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PESA Oil & Gas 101

Overview of Completions and Well Interventions

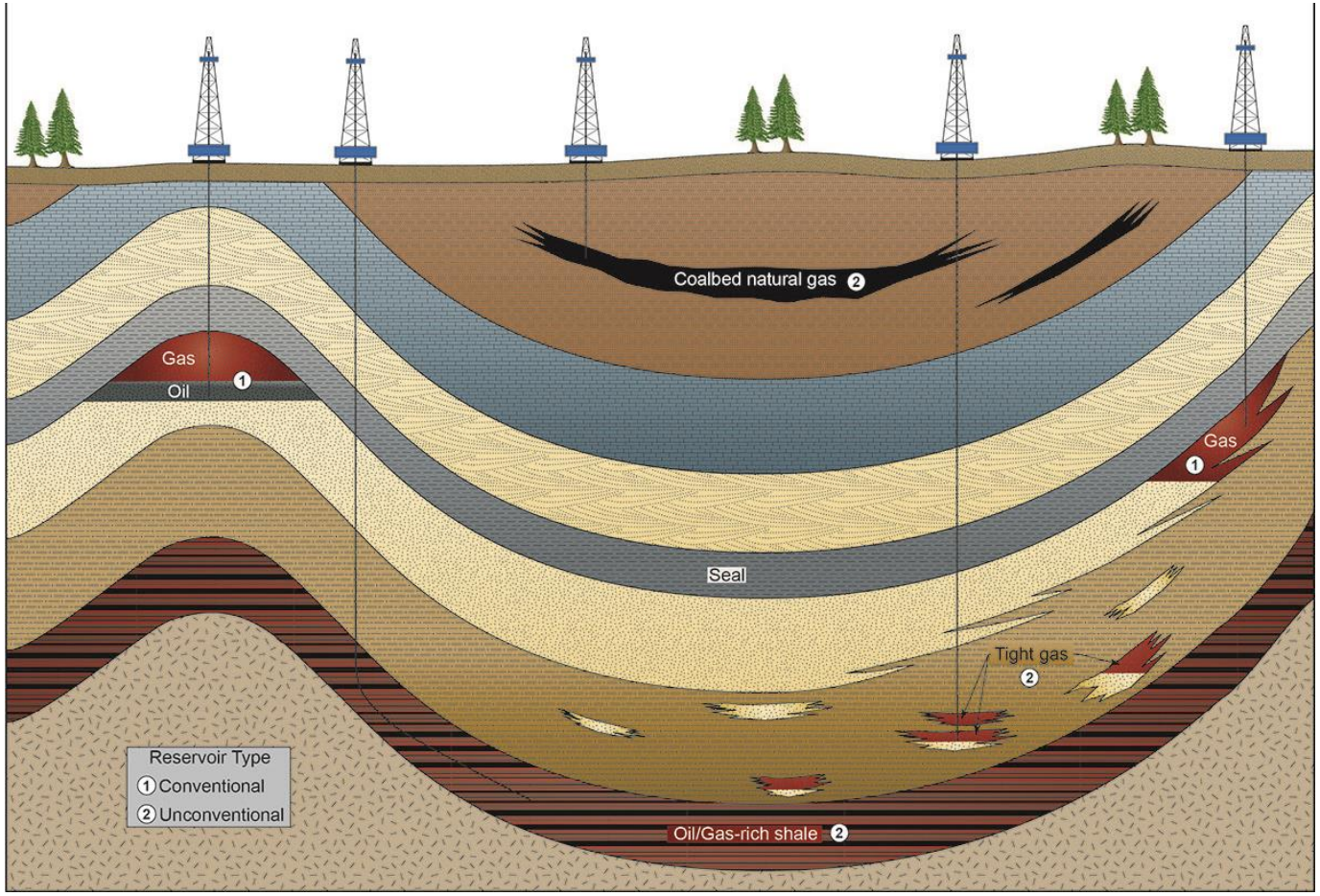
Jason Harper

October 2, 2019

Outline

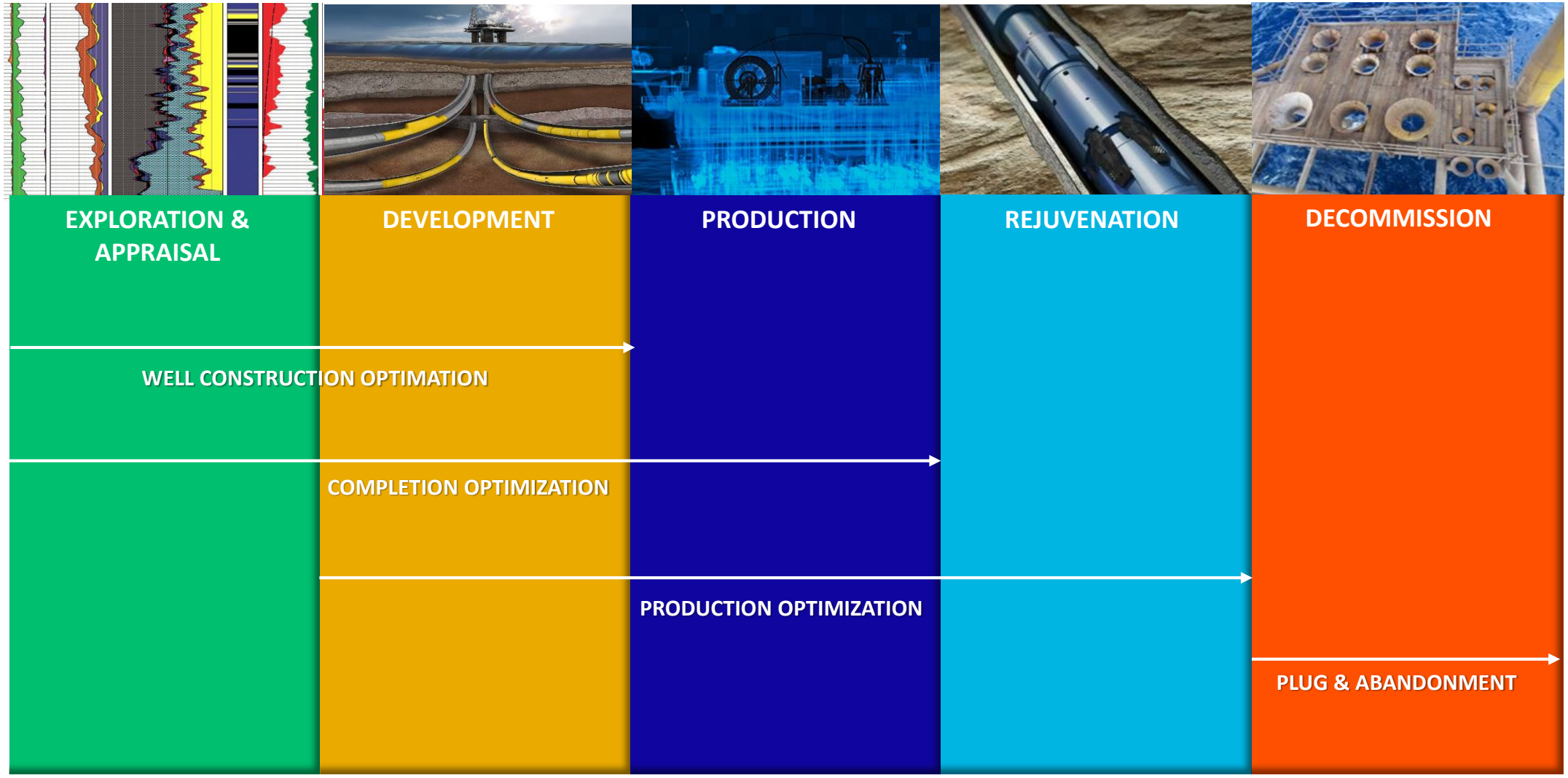
- Background
- Drivers affecting selection of completion types
- Major completion components
- Examples of completion types
- Evolving Technologies

Oil and Gas Reservoirs



Source: Wyoming State University

The Well Life Cycle



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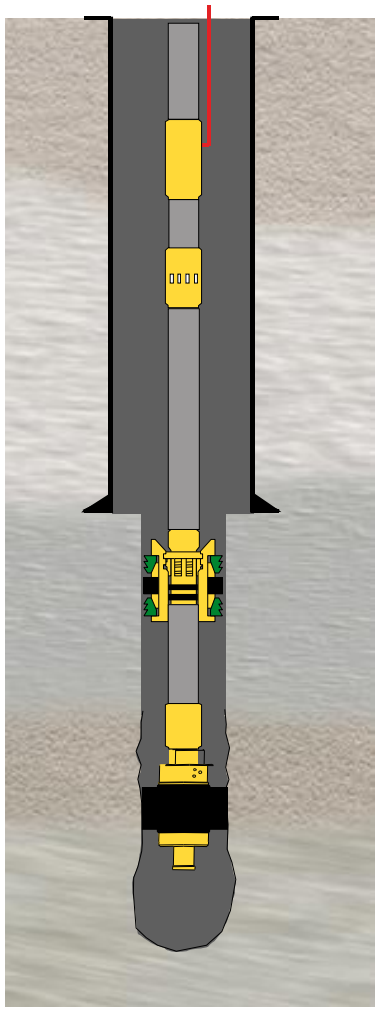
Completion Functions

- Provide pathway for fluid from the reservoir into the wellbore
- Provide pathway for wellbore fluids to surface
- Control the production rate from the reservoir
- Isolate or control problematic sections of the well
- Allow access for well maintenance
- Facilitate stimulation
- Maintain safety



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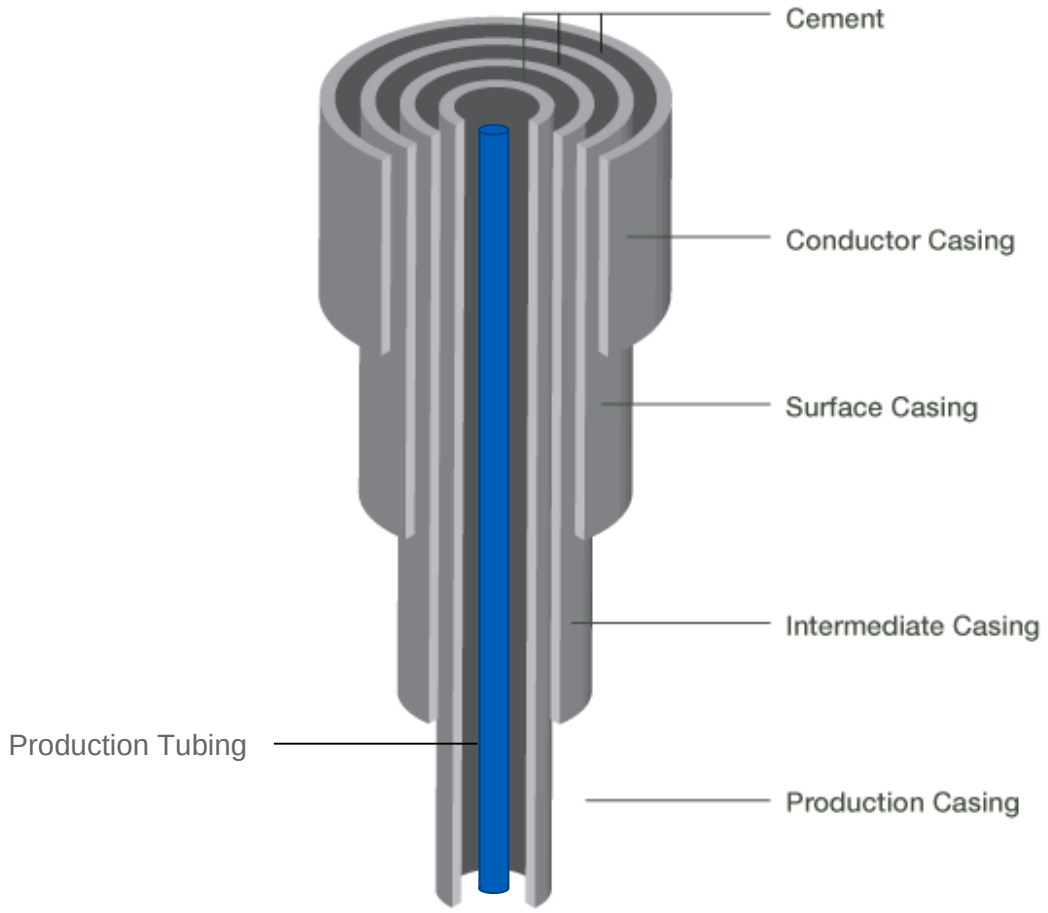
Building A Well: Cross Section



Source: Cabot Oil & Gas – Well Said

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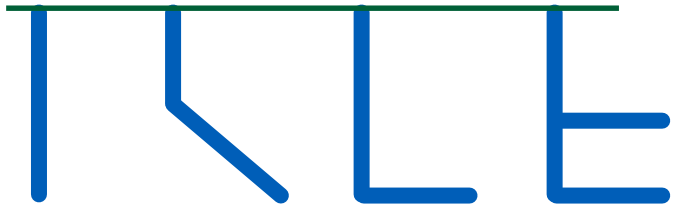
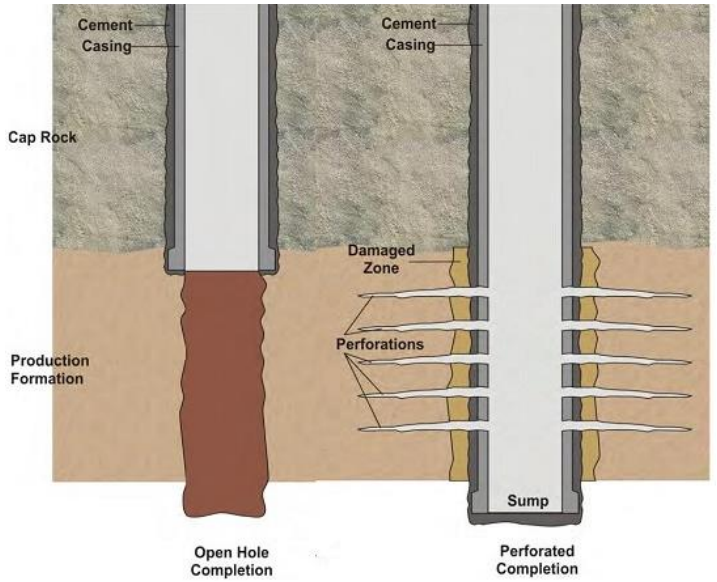
Completion Classifications



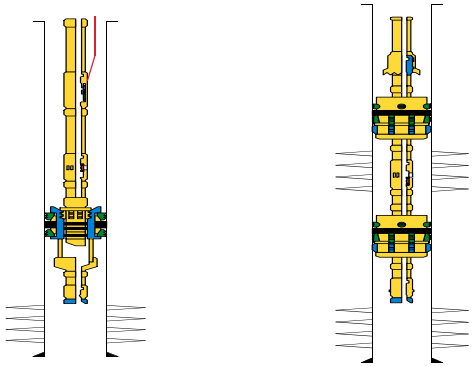
- **Well Path**
  Vertical
  Deviated
  Horizontal
  Multilateral

- **Reservoir access**
  Open Hole
  Cased and Perforated



Petro-Tech Consulting and Training Services

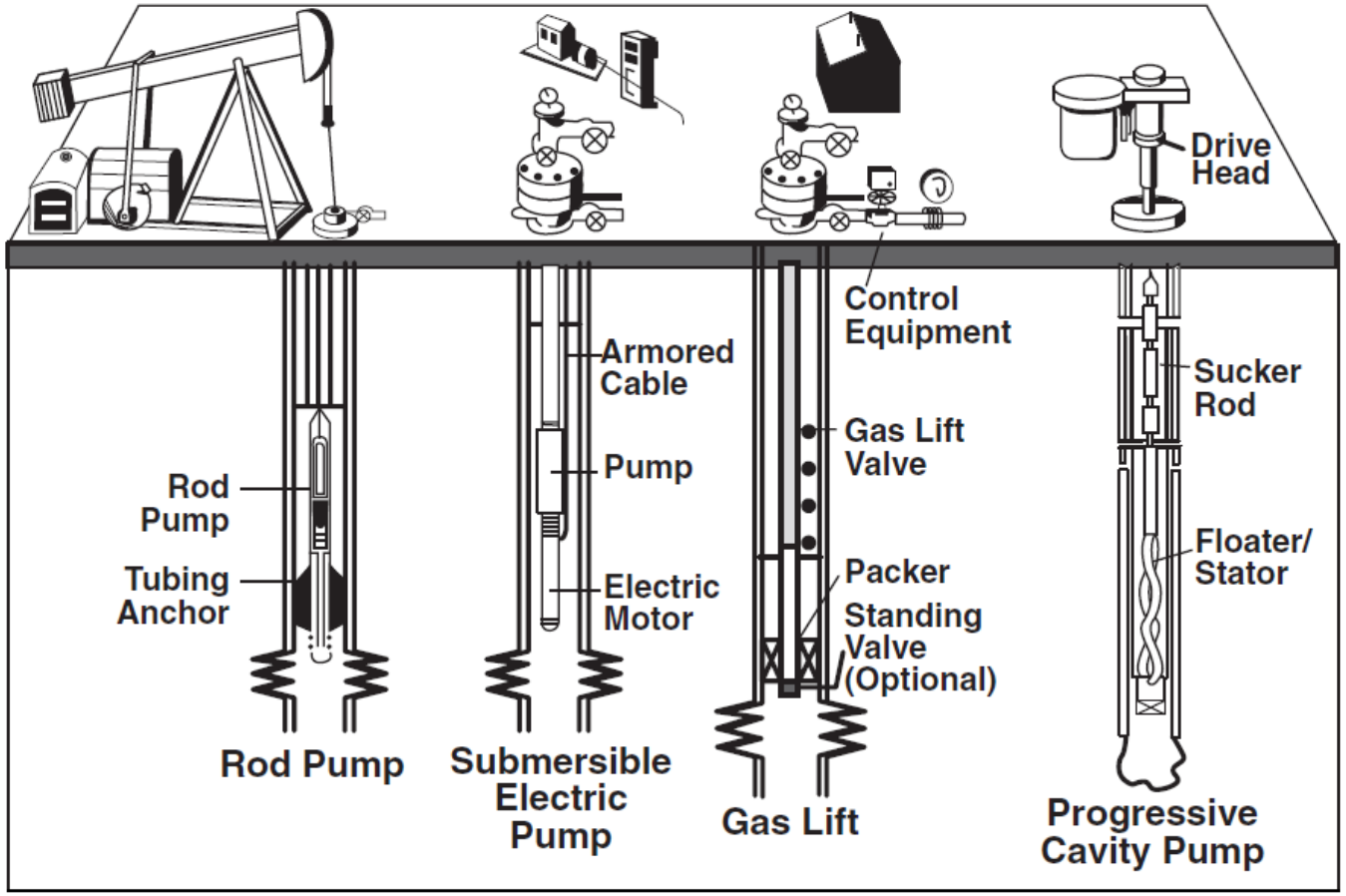
- **Number of zones**
  Single
  Multiple




Credit: Library of Congress

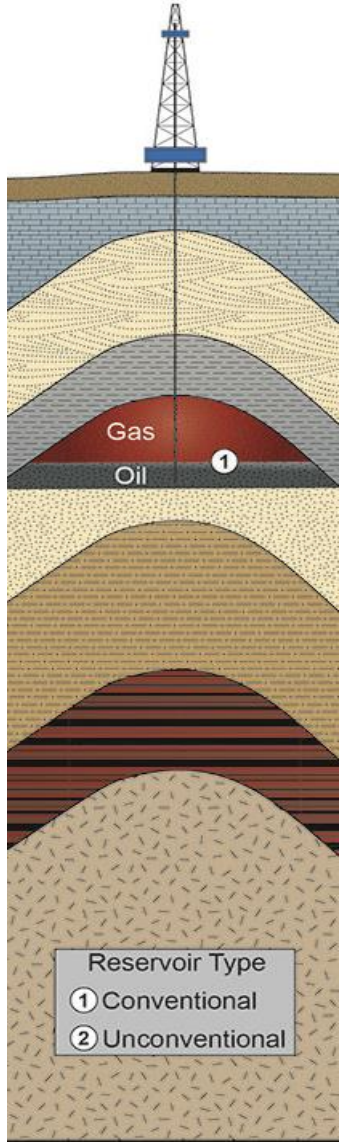
- **Mode of production**
  Flowing
  Artificial lift

Artificial Lift



Other Drivers

- Reservoir type
- Target resource type, extent, depth
- Financial objectives or constraints
- Regulatory environment
- Intervention or re-entry costs in well environment
- Expected well performance/life cycle
- Monitoring requirements



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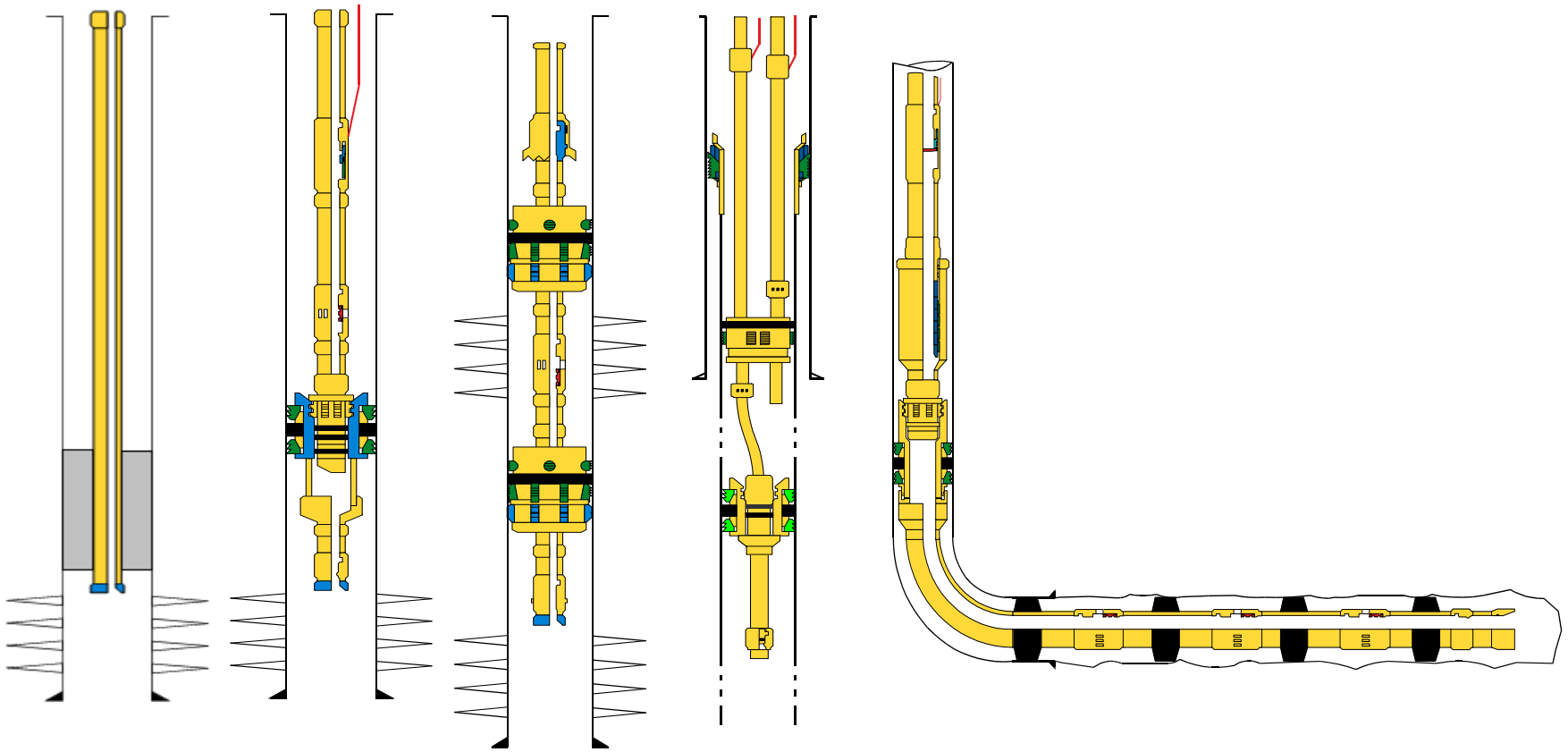
Progression of Completions Through Time



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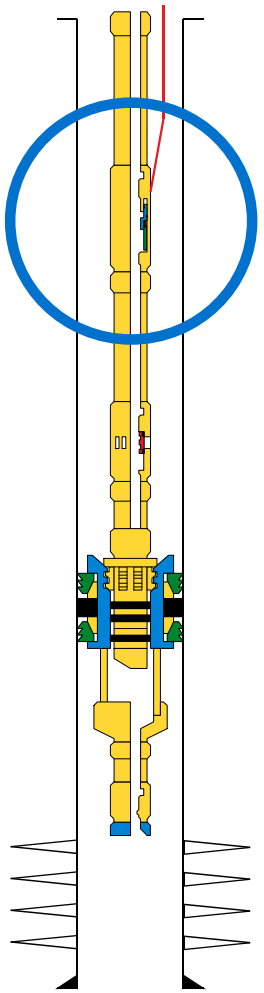
Subsurface Safety Valve



- Deployed on tubing.
- Prevents uncontrolled flow from a well in the case of an emergency.
- Typically shallowest downhole equipment.
- Activated by a change in conditions
- Designs vary by application.
- Most stringently tested product in completions.

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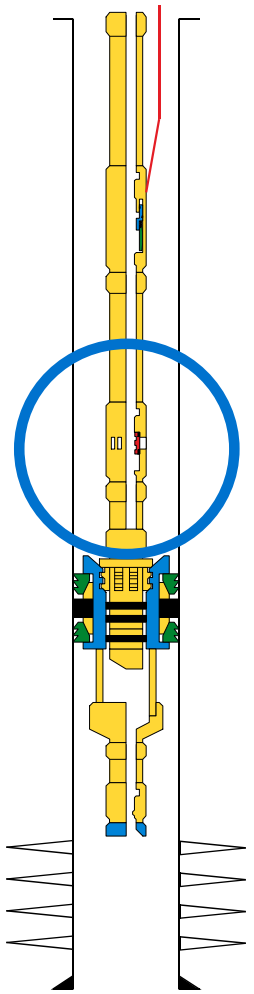
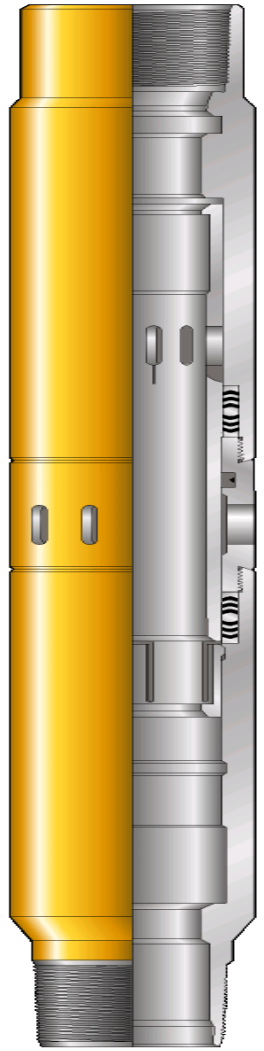
Flow Control Devices – Sleeves



- Position-able valves allowing a flow path between the inside and outside of tubing
- Shifted via several means
  Mechanical
  Hydraulic
  Electric
- Multi-cycle and multi-position versions available



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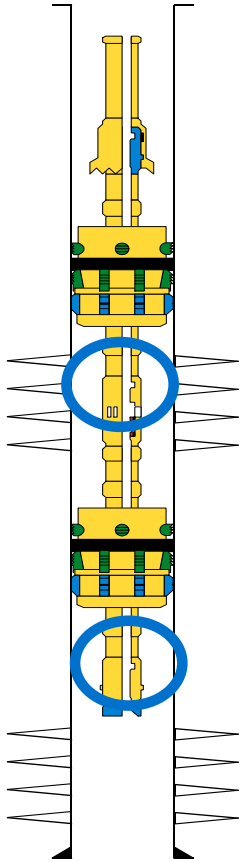
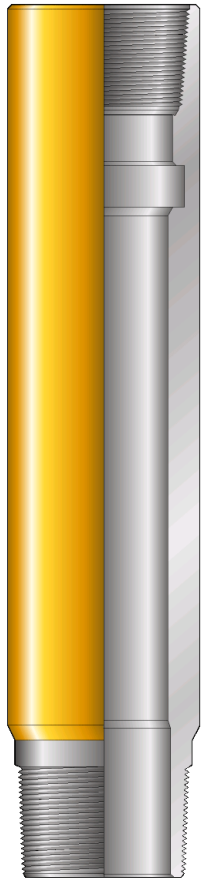
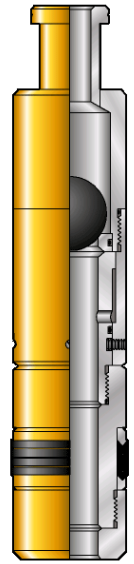
Flow Control Devices – Profile Nipples



- Profiles placed in tubing able to receive latching accessories
  Accessories include plugs, chokes, check valves
  Accessories typically retrievable





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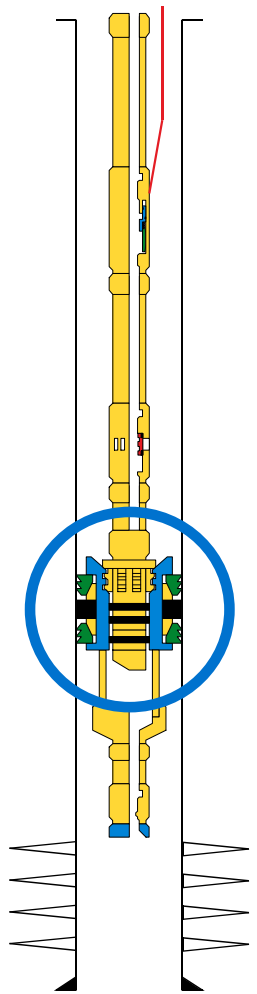
Isolation Devices - Packers

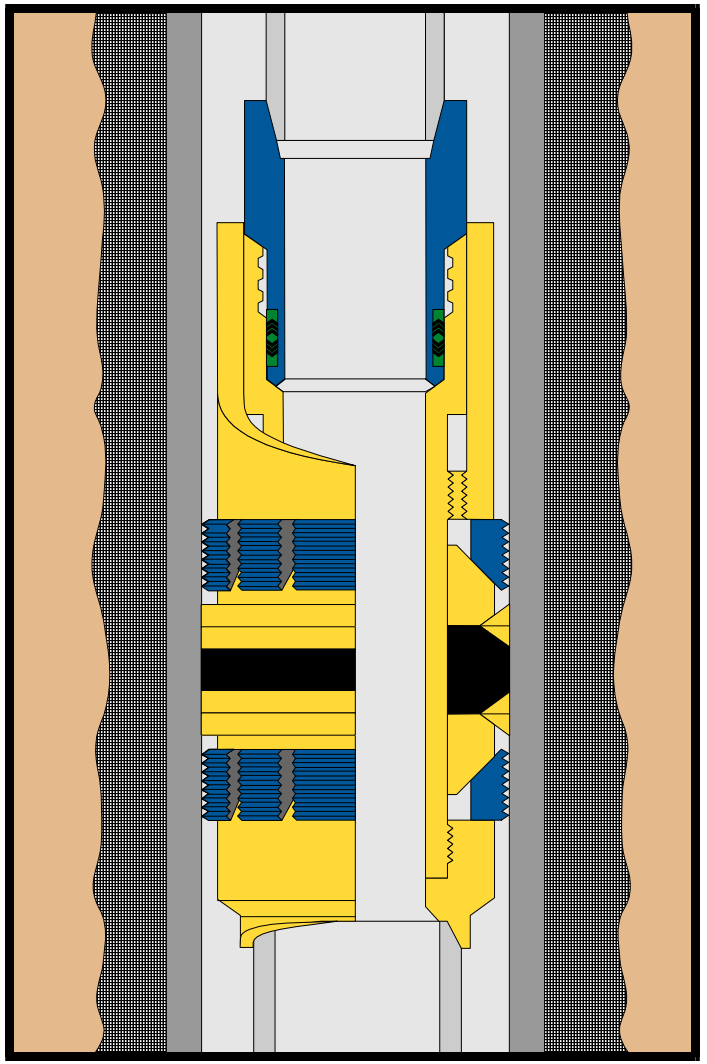


- Mechanical device – seal between casing and tubing.
- Located above producing zone(s).
- Parts

  Sealing element.

  Slips (anchors).

  Various parts and piston areas that allow setting.
- Well control.
- Corrosion control.



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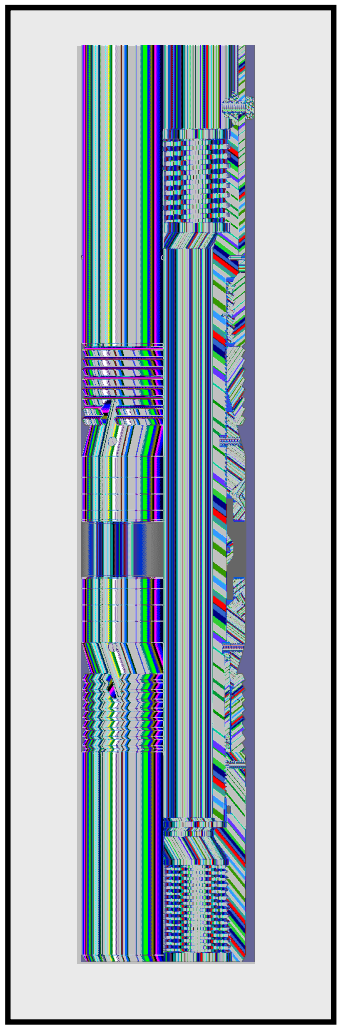
Packers Types

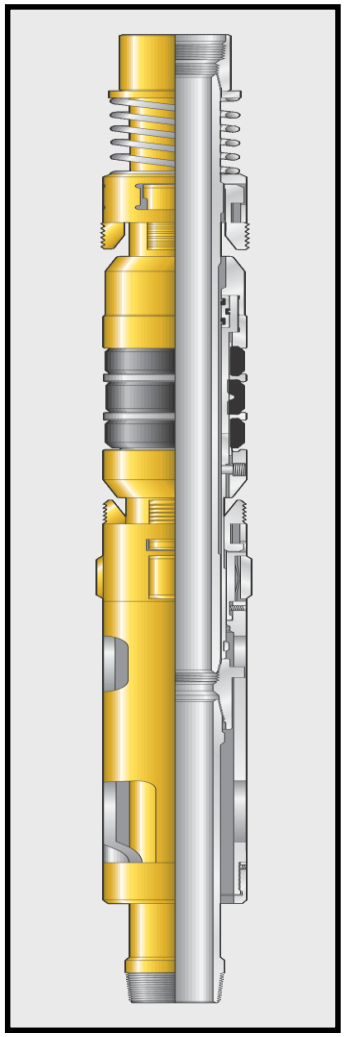


- Permanent
- Retrievable
- Removable

- Mechanical set
- Hydraulic set

- Cased Hole
- Open Hole

- Inflatable
- Swelling



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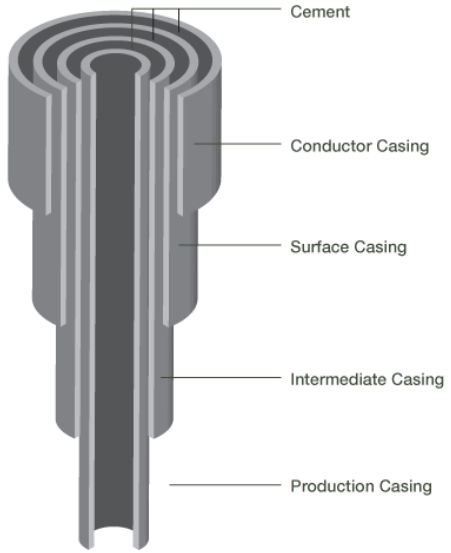
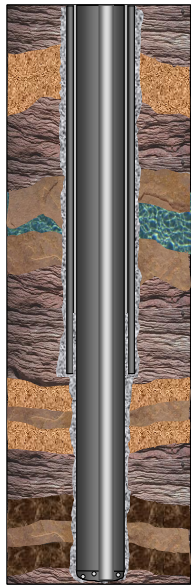
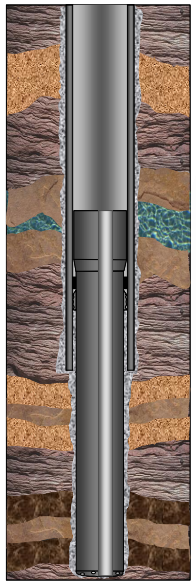
Structural Devices – Hangers

- Mechanical devices that anchor sections of pipe
- Typically use slips to attach deployed pipe to host pipe
- May be run with packer to provide isolation

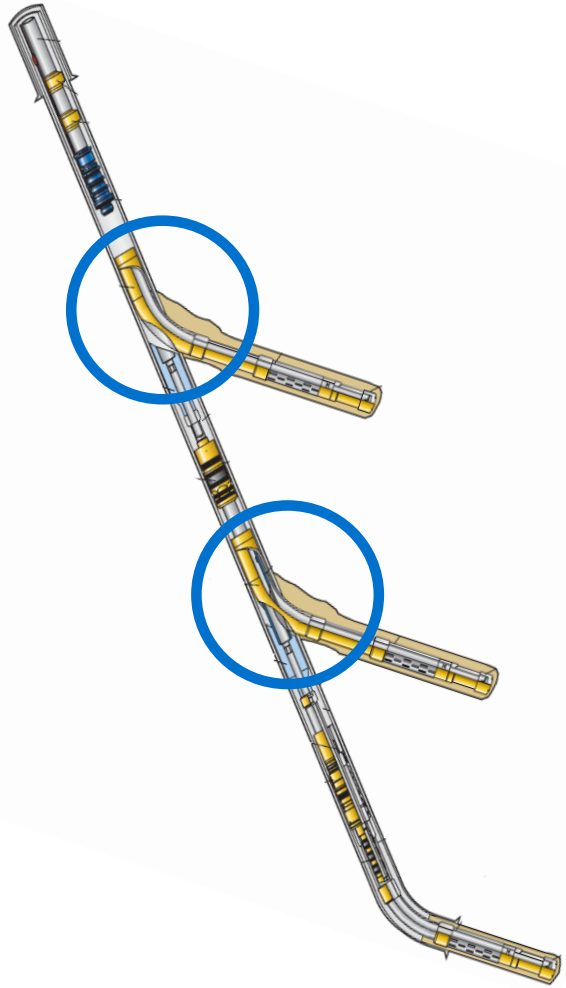




Long String

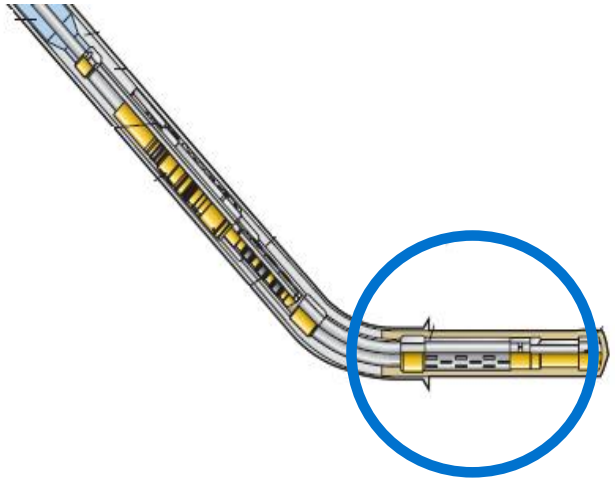


Liner



Filtration Devices - Screens

- Filters built onto perforated tubing
- Intended to limit the size of particles that can be admitted into the tubing
- Usable in
  - Open-hole
  - Perforated casing
  - In conjunction with other filters



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Inflow or Injection Control Valves

- Passive or autonomously adjusting devices that help drain, (or distribute fluid to) reservoirs evenly

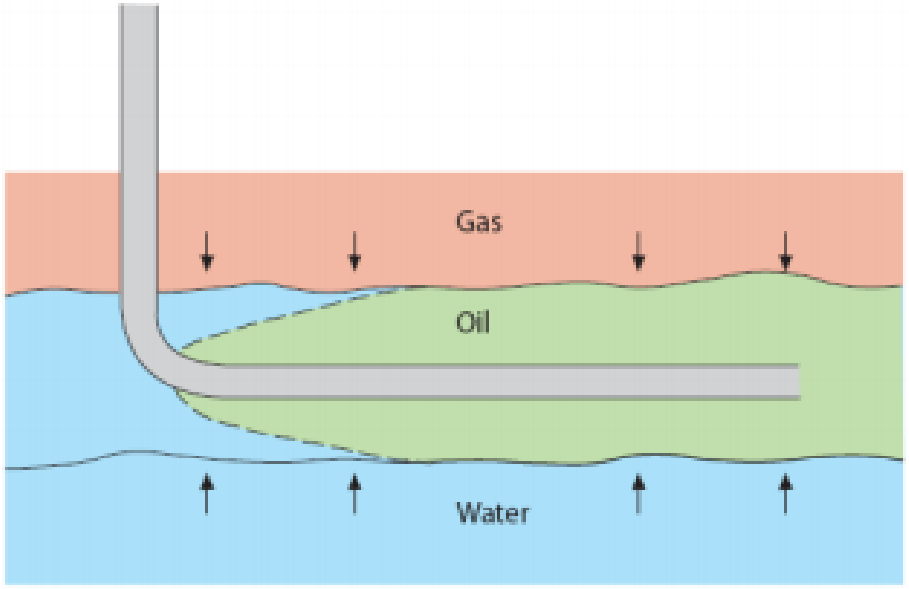

Figure 1: Coning in a long horizontal well.

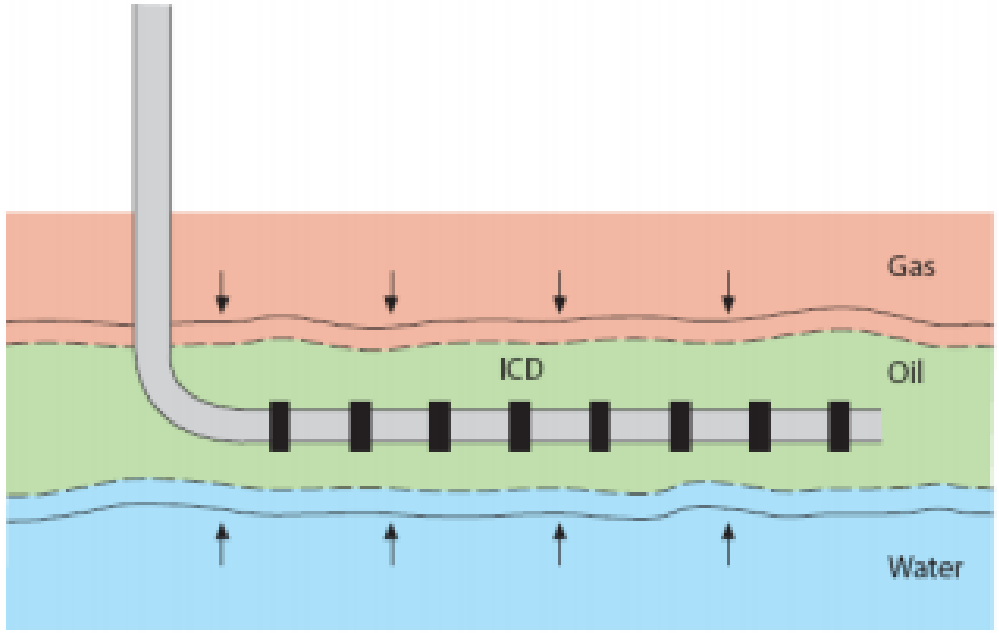

Figure 2: Avoiding coning by applying ICDs.

Source: Hanzen Energy Services

Intervention and Recompletion

- Cleanup
  Removing debris from the wellbore

- Isolation
  Setting permanent or temporary plugs/ flow barriers

- Fishing
  Recovering lost equipment or pipe

- Casing exits
  Creating a new wellbore by milling out of existing casing

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Conveyance or Deployment Methods

Outline

- Background
- Drivers affecting selection of completion types
- Major completion components
- **Examples of completion types**
- Evolving Technologies

Application Specific Completions

- **Sand Control Completions**
  Aimed at limiting production of solids
- **Unconventional Completions**
  Enable efficient, multi-stage fracturing treatments and minimize time until production begins
- **Intelligent Completions**
  Allow active control of completion subsystems via electric or hydraulic control
  Limit need to re-enter well

Sand Control Completions

- Tools & services to minimize or prevent sand production in unconsolidated reservoirs
- Drivers: reliability, production enhancement, efficiency, long term production

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Controlling Sand Production Minimizes…

- Equipment damage
- Maintenance costs
- Well plugging
- Disposal costs

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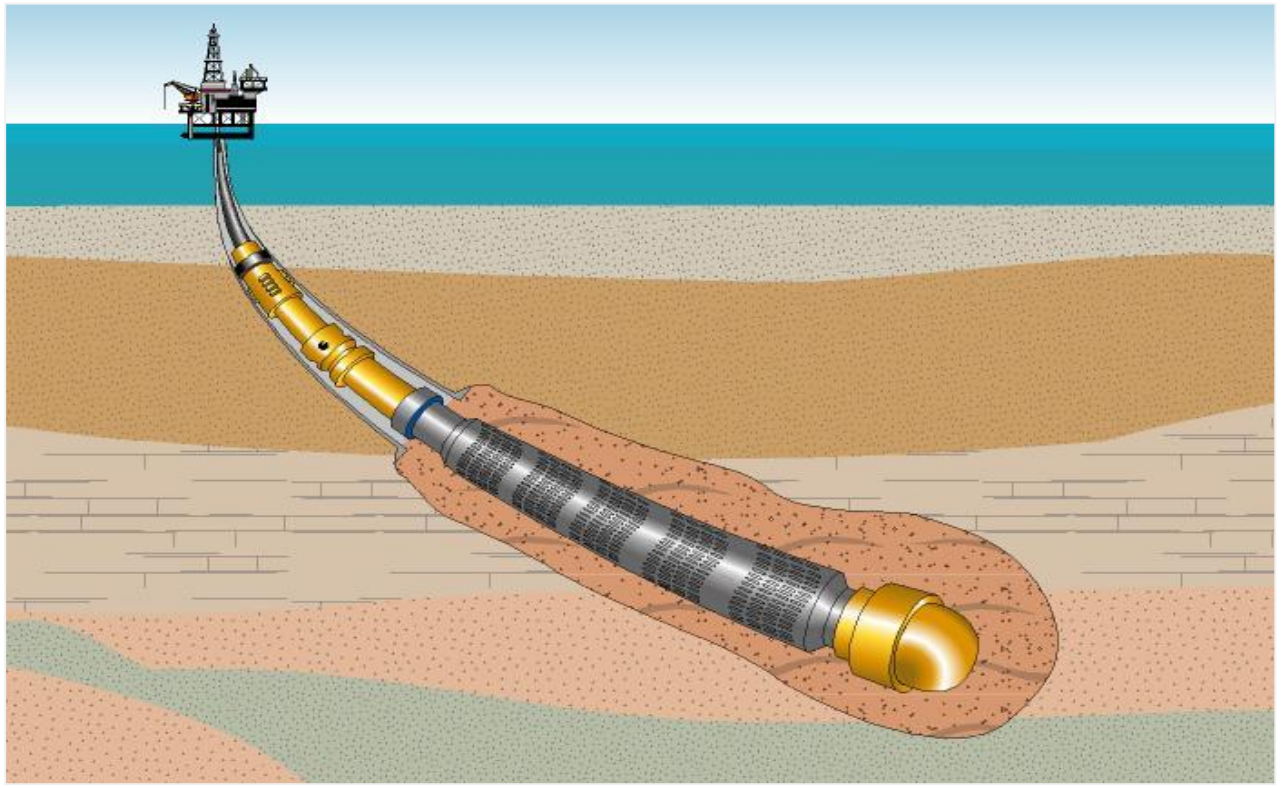
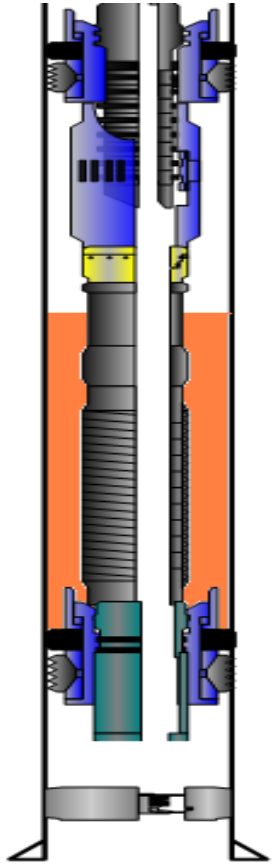
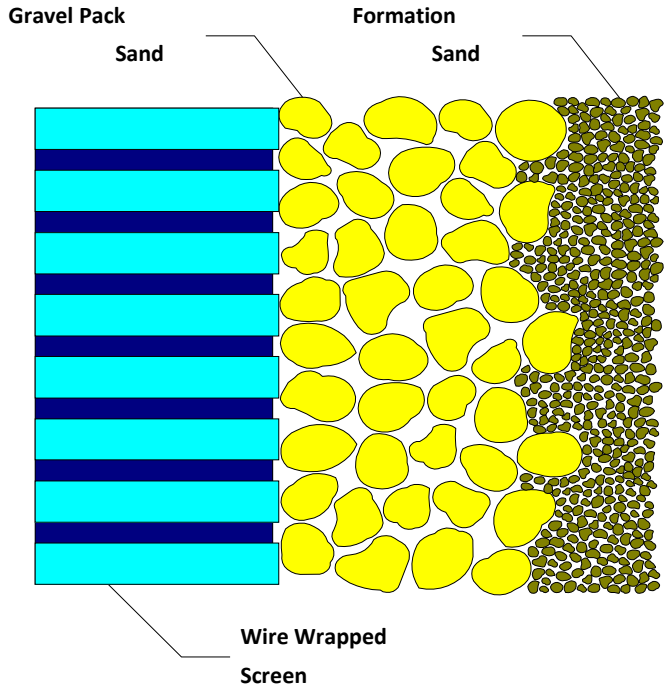
Sand Control Completion

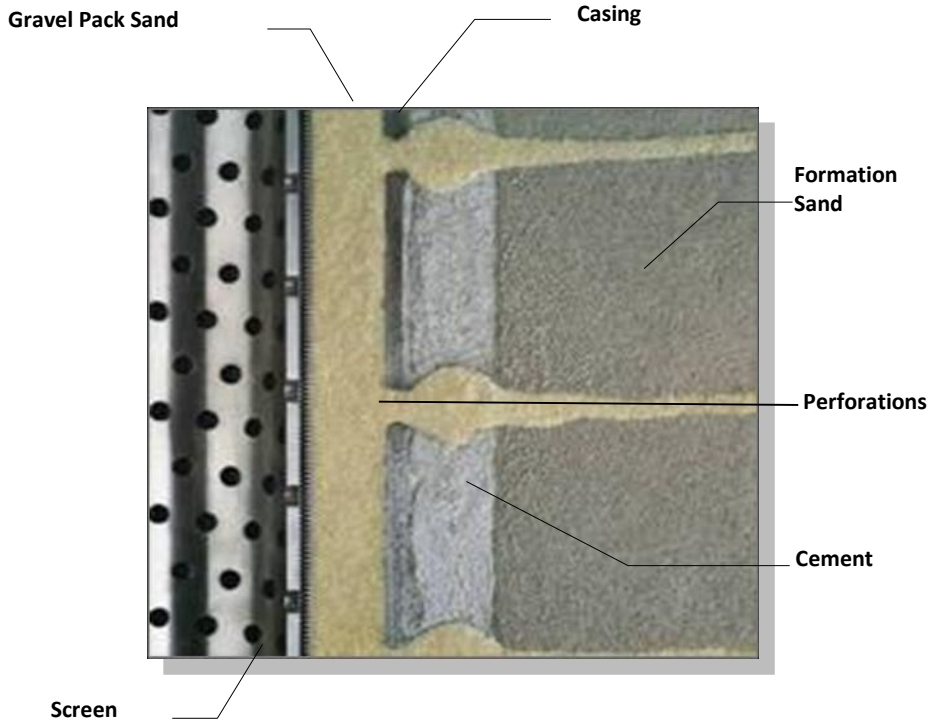




Gravel Packing



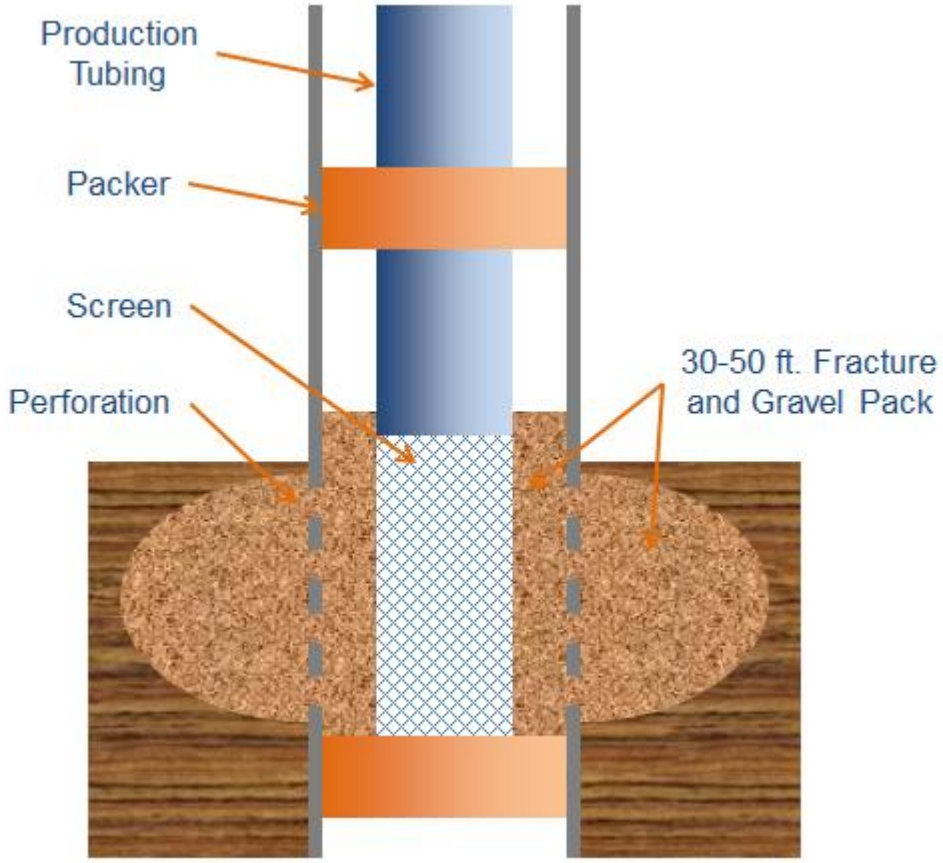
Open
Hole



Cased
Hole

FracPacking

- Similar to gravel packing
- Higher pumping pressures and rates
- Rock strength or fracture pressure of rock exceeded
- Breaking or ‘Fracturing’ the formation
- Packing near wellbore to similar to gravel packing



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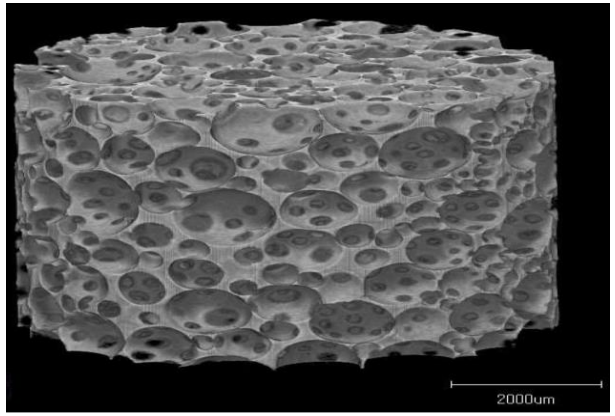
Shape Memory Polymer



Objective

- Reduce overall field development costs and risk compared to traditional extended reach OHGP and multi-zone completions
- Increase overall production and return on investment

Scope / Features

- Compliance to the formation provides sand control for broad range of particle sizes
- Enables completion of reservoirs that would be difficult to gravel-pack due to very fine formation sands, wide particle size distributions, multiple zones, or low fracture gradients.
- Enables completion of very long reservoirs and complex multi-laterals
- Reduces equipment and manpower required for sand control completions

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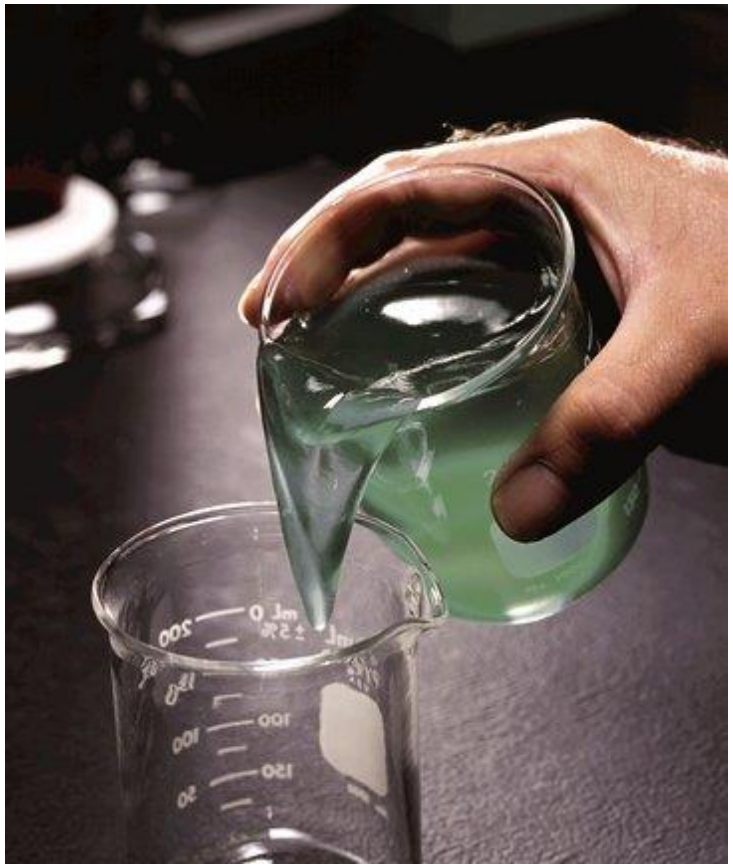
Sand Control Pumping Services

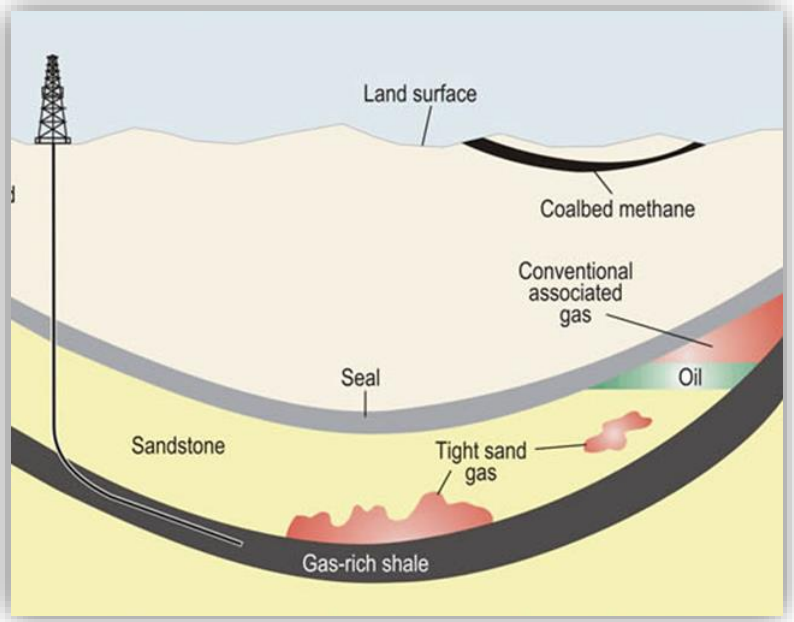


- Slurry
  Combination of proppant/sand and carrier fluid

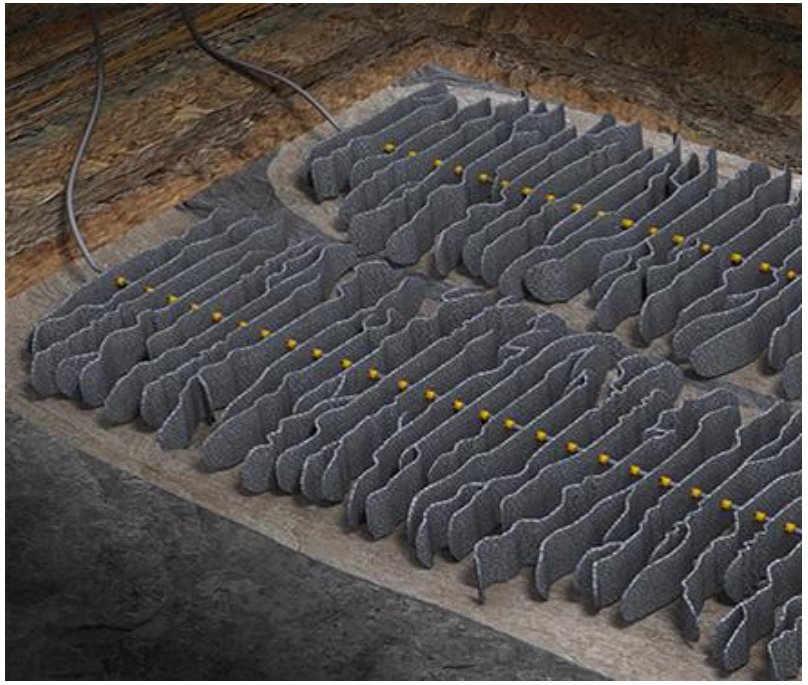
- Carrier Fluids
  Engineered fluids designed to carry proppant with one viscosity, and then “break” to a lower viscosity allowing to return to surface

Unconventional Completions

- Completion systems enabling access to non-traditional reservoirs – often requiring multistage Hydraulic Fracturing
- Drivers: efficiency, reliability, cost



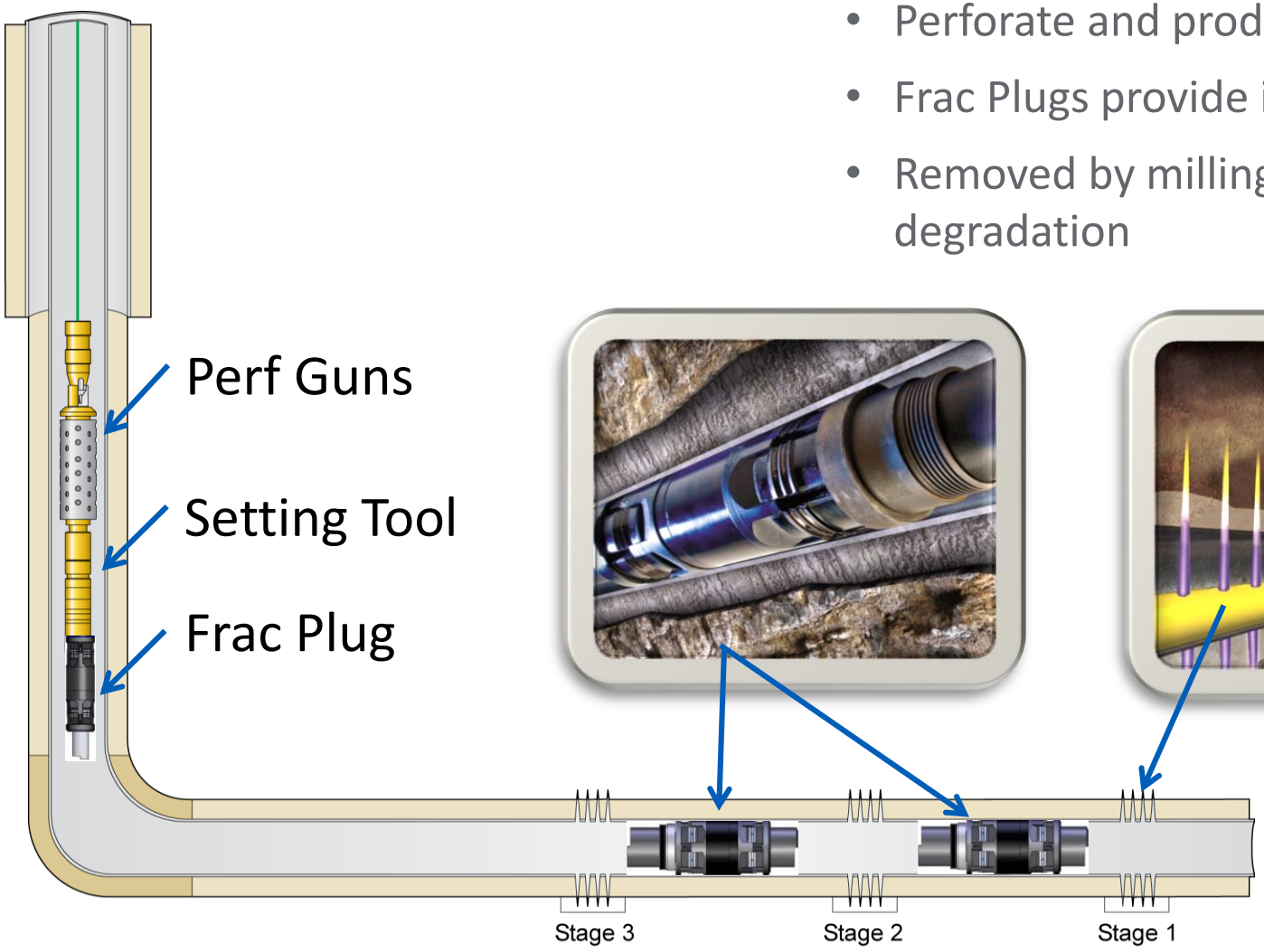
© Wyoming State Geological Survey

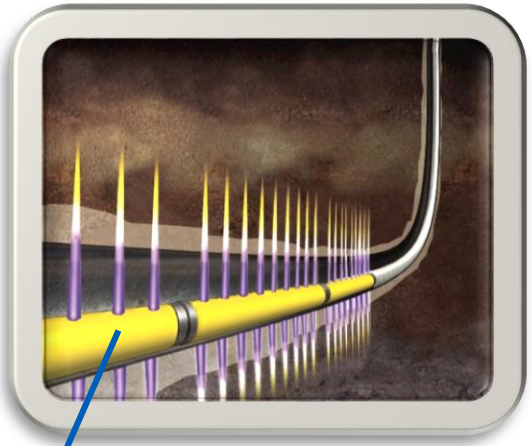


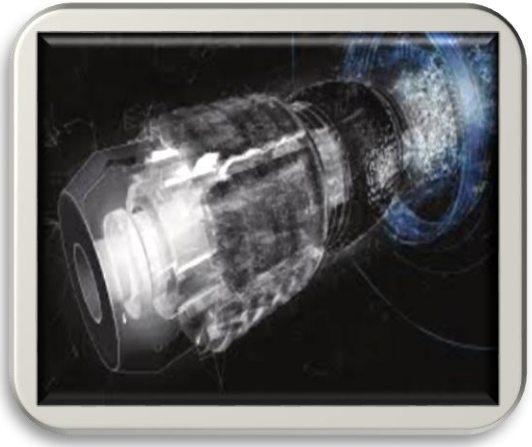
© Schlumberger

Plug & Perforate

- Cemented casing liner or full string
- Perforate and produce multiple pay zones with Perf Guns / TCP
- Frac Plugs provide isolation
- Removed by milling with coil or pipe, or via engineered degradation







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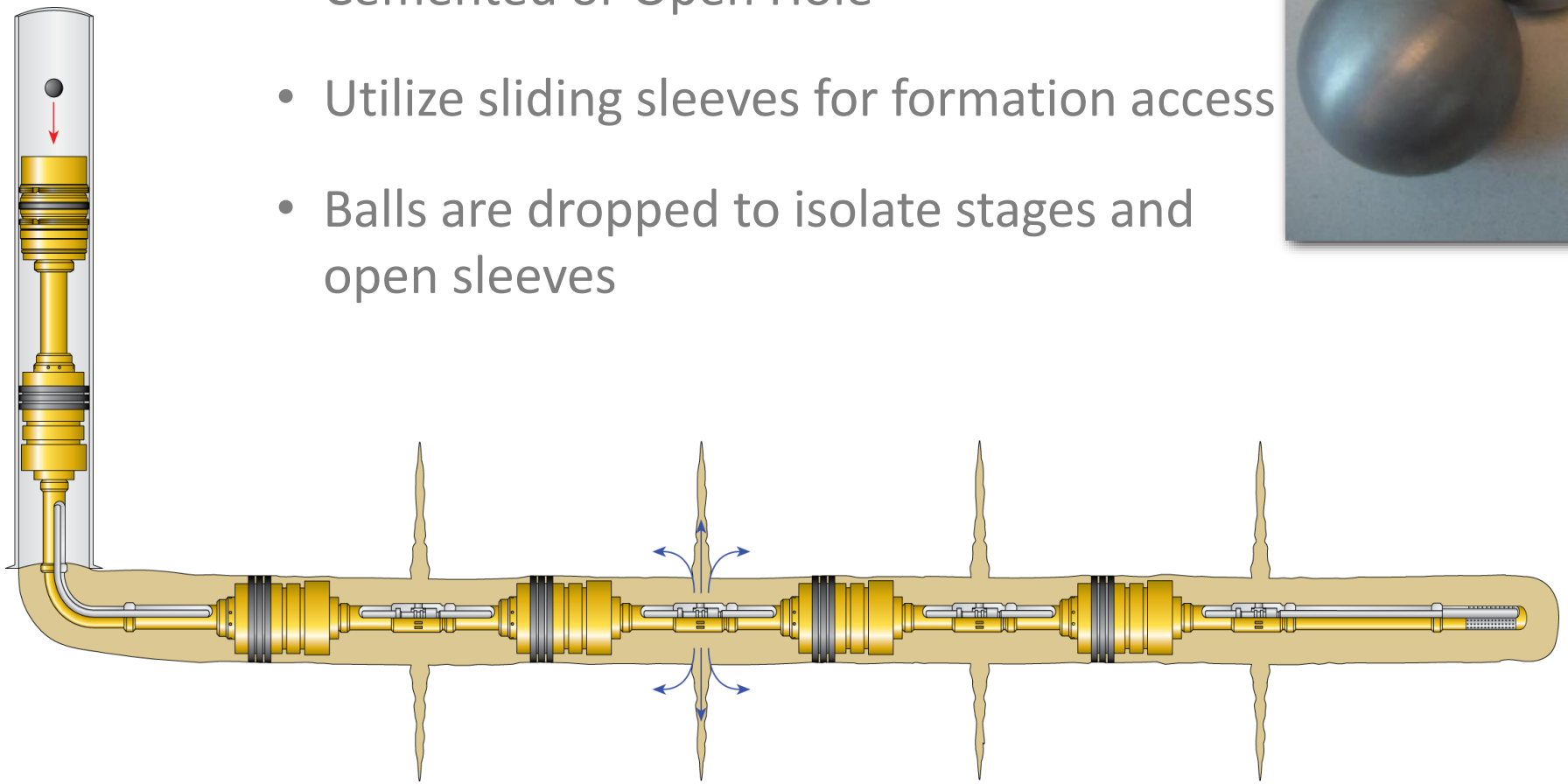
Ball Activated Systems

- Cemented or Open Hole
- Utilize sliding sleeves for formation access
- Balls are dropped to isolate stages and open sleeves



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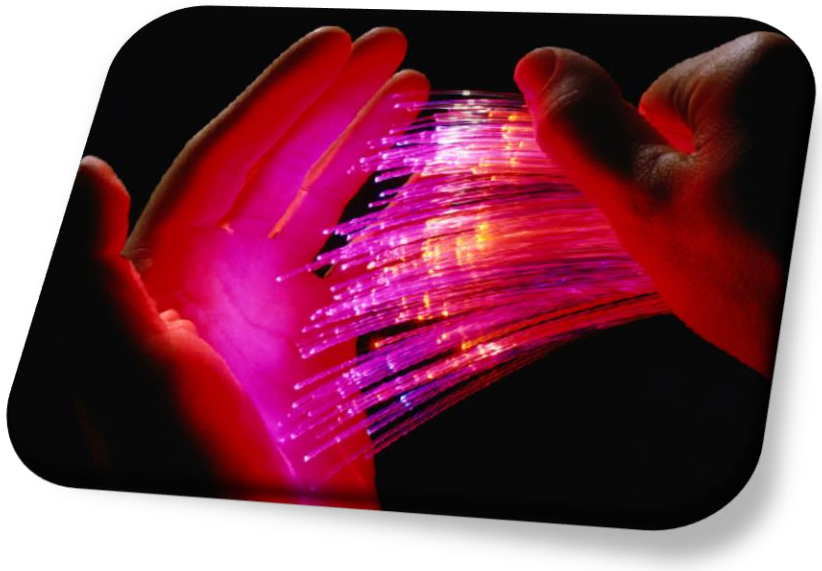
Coiled Tubing Annular Fracturing

- Cemented or Open Hole
- Utilize sliding sleeves or sand jet perforating
- Coiled Tubing is used to convey a packer assembly to provide isolation and access to reservoir

Well Monitoring

- Discrete Gauges permanently installed on completion assembly to measure real time
  - Discrete Pressure
  - Discrete Temperature
  - Flow Rate
  - Water Cut
  - Density

- Distributed measurements
  - Fiber Optic Distributed Temperature
  - Fiber Optic Distributed Acoustic
  - Fiber Optic Distributed Strain



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Intelligent Completion Systems

- Wells able to monitor and adjust the condition of downhole devices
- Often in offshore environments, where cost of re-entry is prohibitive
- Enhancements of previously discussed equipment

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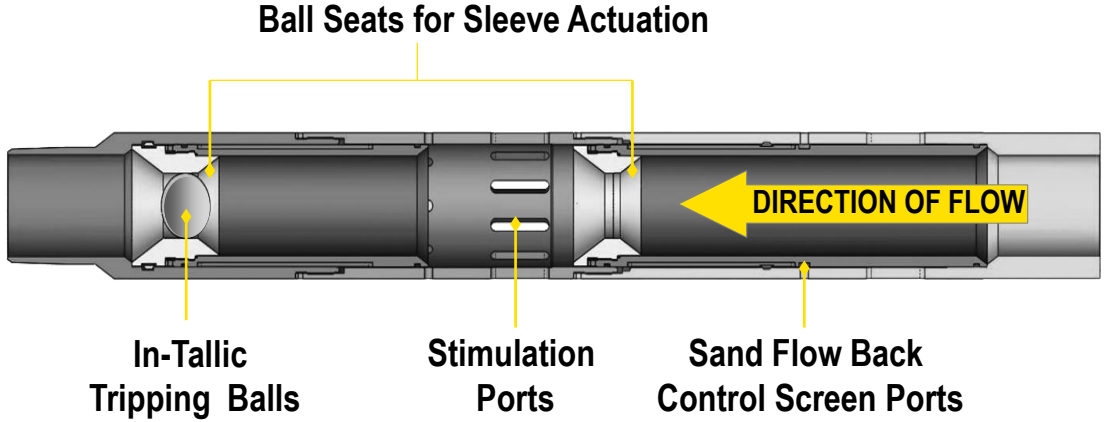
Evolving Technologies

- Deepwater multistage fracturing system
- Adapted from onshore unconventional systems
- Allows stimulation and completion of deepwater reservoirs
- Reduces deployment time
- Reduces job complexity



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Intelligent Wetmate System

Enabling two-trip completion installation

Benefits

- Flexibility for the life of the well
- Reduced complexity and cost of interventions
- Ability to reach longer depths with intelligent completions

Features

- Debris Management Design
- Universal carrier for flexible configuration
- Each pocket contains either

  Two hydraulic lines

  One 1, 2, or 3 conductor electrical line

  One 6-fibre line

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Thank You