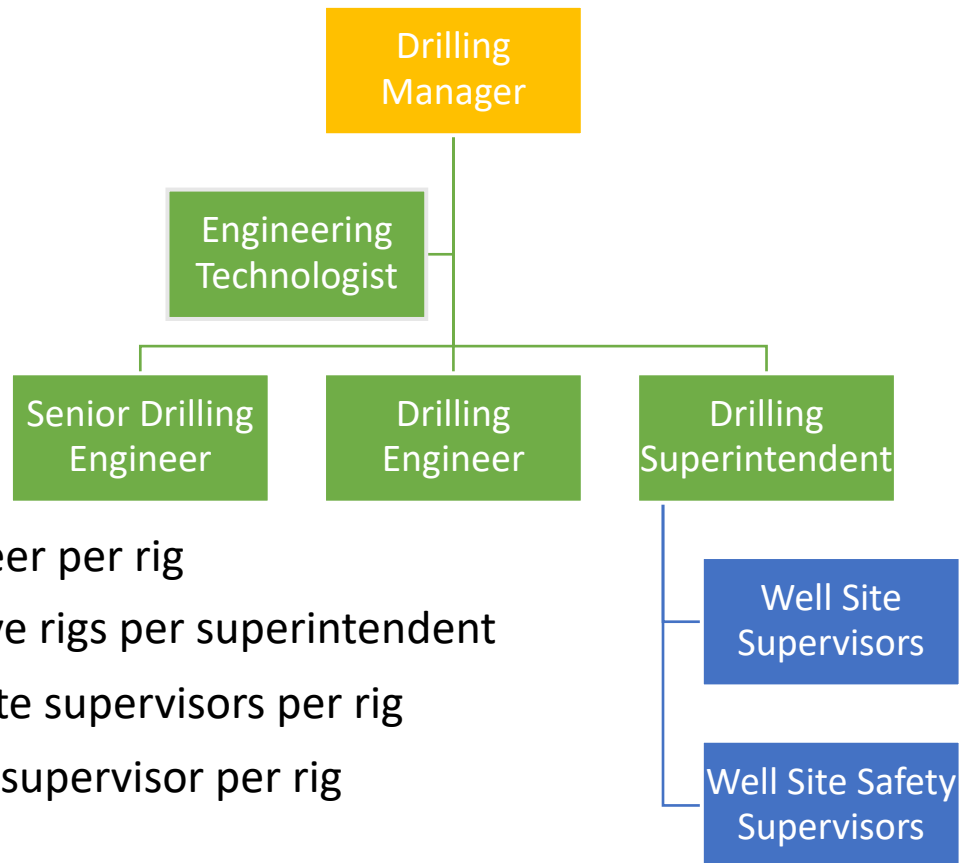




Slippery Rock Introductory Drilling

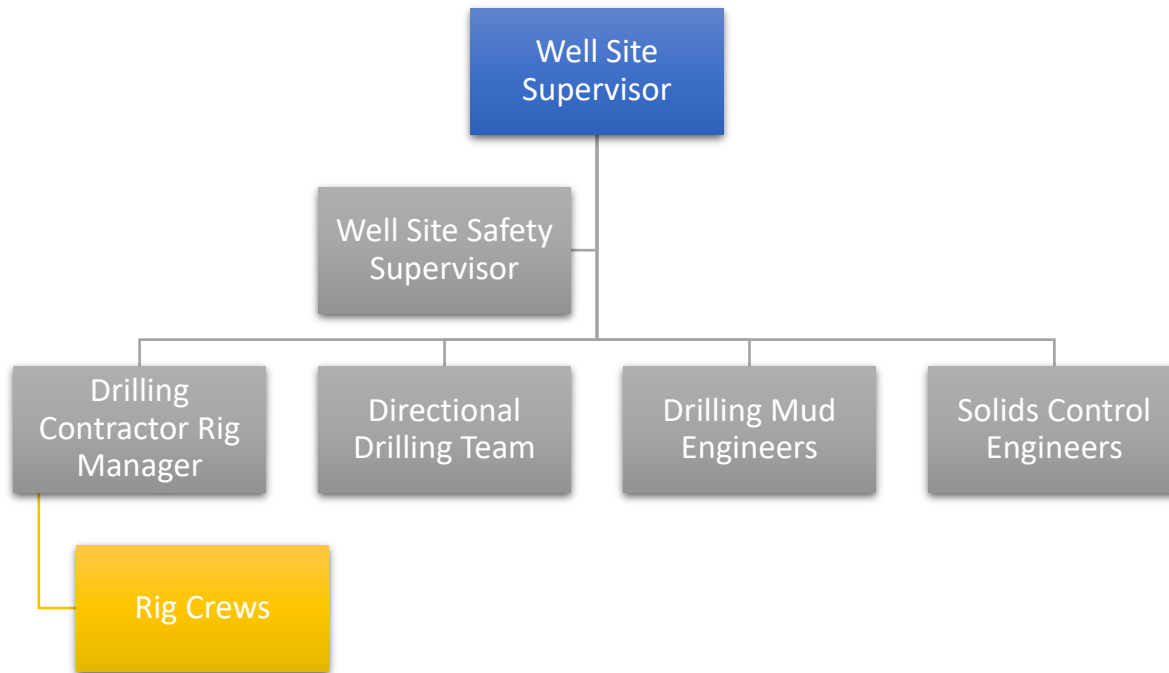
April 17, 2024

Typical Office Based Drilling Organization



- One engineer per rig
- Three to five rigs per superintendent
- Two well site supervisors per rig
- One safety supervisor per rig (optional)

Rig Site Organization



Onshore Drilling Rig



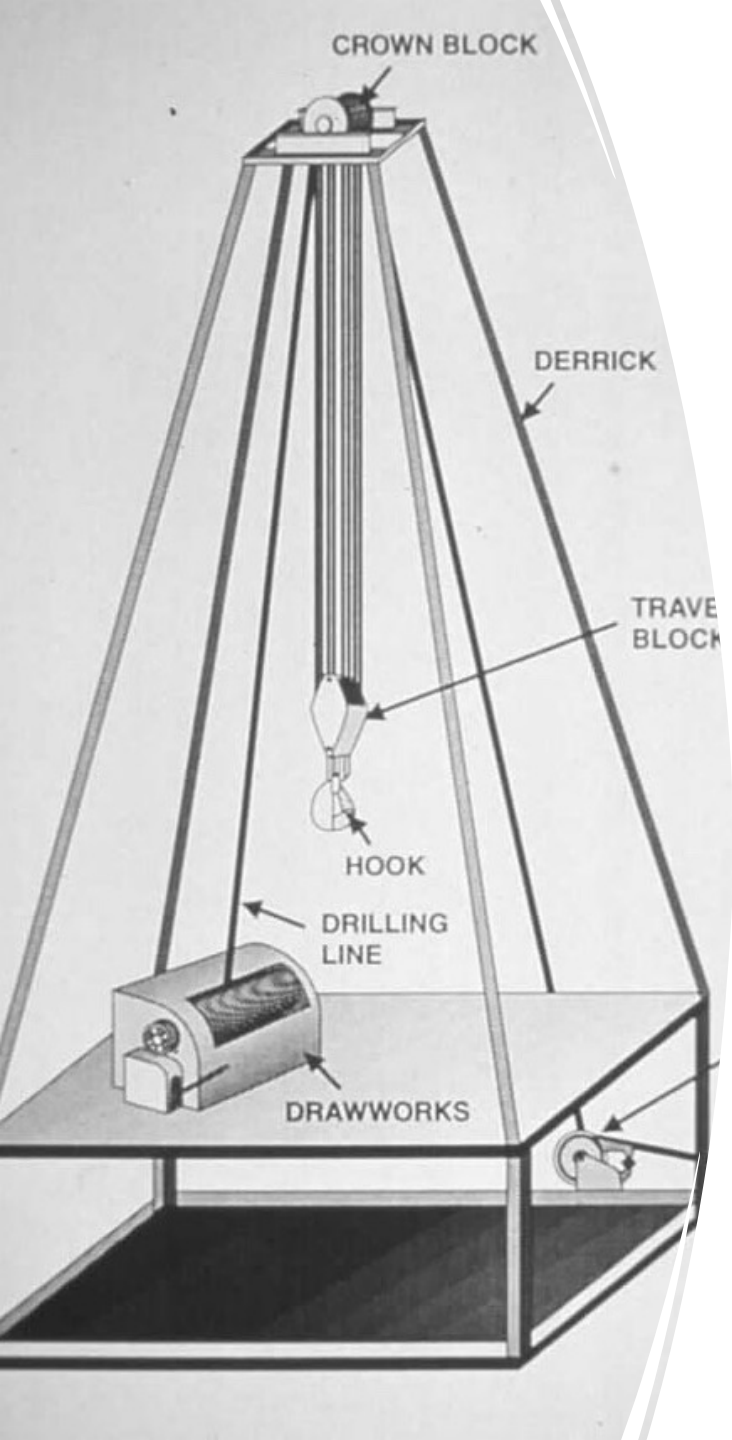
Rig Components

- **The Power System**
- Hoisting
- Rotating
- Circulating

Rig Power Source

- Almost all newer rigs use AC electrical power. AC power is generated using diesel engines paired with AC generators.
- Engine count increases as the hook load capacity & rig power requirements increase
- Some rigs are Dual Power, meaning they can equally burn diesel or natural gas, either compressed, field or LNG
- Some rigs can also tie into grid power
- Typical 1500 hp rig produces 4.5 MW, or enough for 4000 homes!





Hoisting System

- Draw works
- Derrick
- Crown block
- Traveling block
- Wire rope
- Electric hoist
- Most 1500 hp rigs can pull 750,000 to 1,000,000 pounds!

Drawworks

- Spool-shaped revolving drum
- Wire rope is wrapped around it while hoisting heavy loads
- Band brakes stop the drum
- Auxiliary brake absorbs some of the momentum of a load



Rig Components

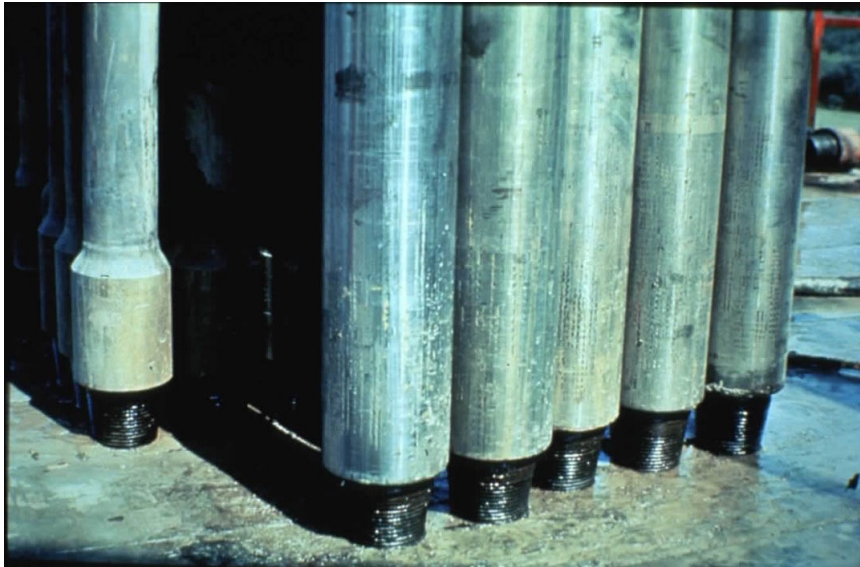
- Power
- Hoisting
- **The Rotating System**
 - Includes the devices that make the bit turn
- Circulating

Top Drive

- Has a powerful motor that turns the drill string
- Rotates with torque while moving up and down
- Adds up to 3 joints of pipe at a time, called a stand
- Eliminates the traditional rotary table
 - Most rigs still have rotary tables, but rarely use them.



Drill String



- Drill pipe
 - Carries drilling mud to the bit
 - Supports the drill collars
 - Turns the bit
 - Tool joints increase the strength of a drill pipe connection
 - Dimensions & steel grade affect drill pipe strength

- Drill collars
 - Supplies weight to run on bit
 - Collars are heavier than drill pipe and provide BHA stiffness

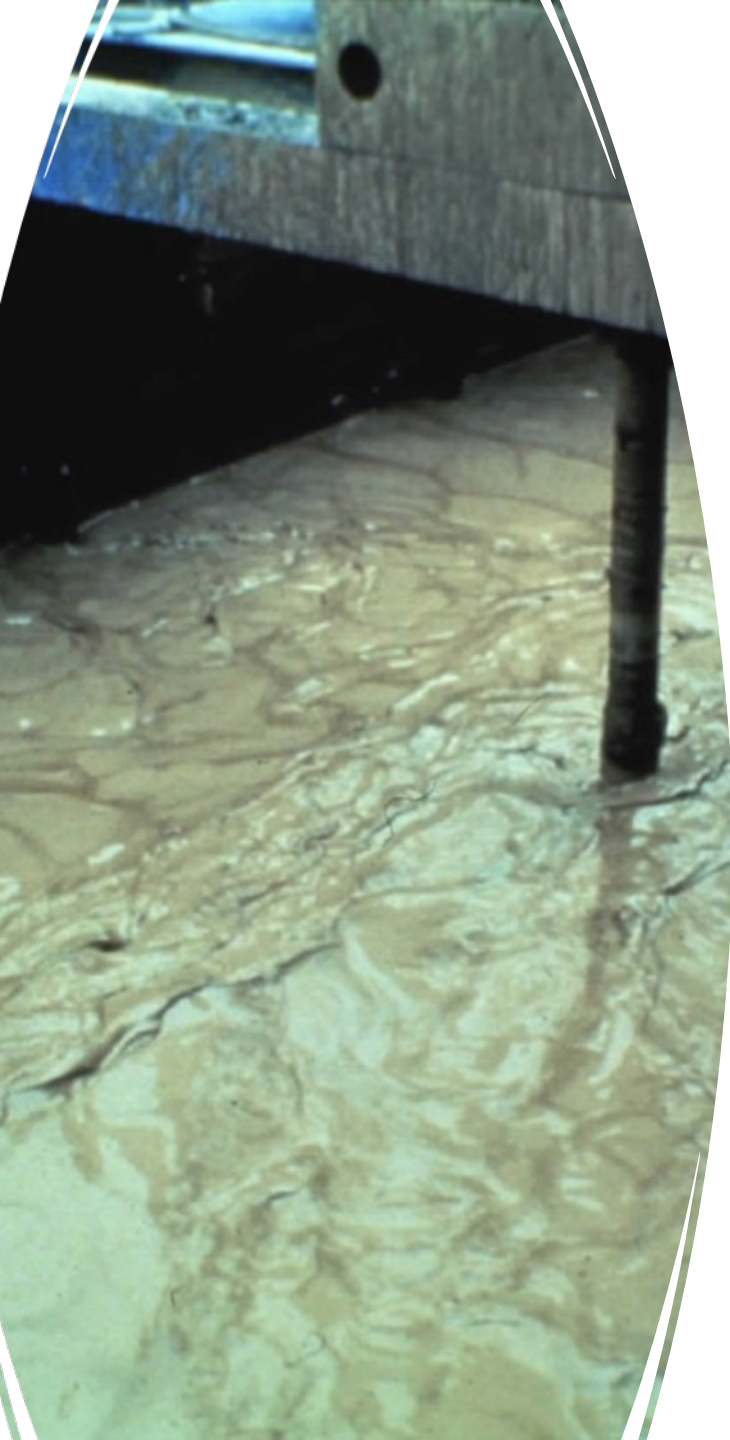
Rig Components

- Power
- Hoisting
- Rotating
- **The Circulating System**

Circulating System

- Drilling Fluid
- Circulating Equipment
 - Mud Pumps
 - Charging Pumps
- Auxiliary Equipment
 - Mud Gas Separator
 - Desilter
 - Desander
 - Shale Shakers
- Well Control Equipment
 - Blow out preventers (BOP's)
 - Accumulator Unit





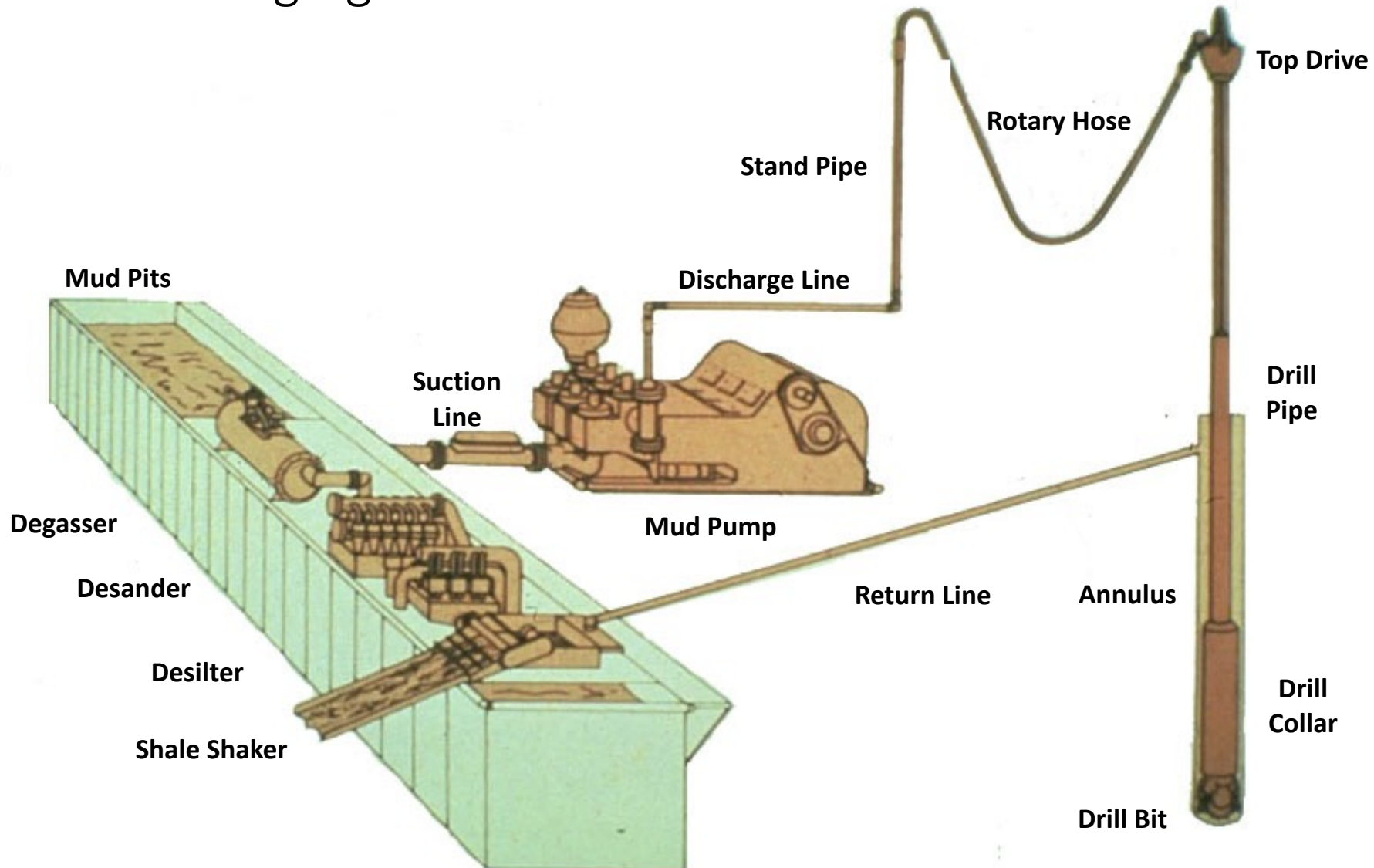
Drilling Fluid

- Primary well control barrier
- Clears cuttings away from bit
- Carries cutting to surface
- Lubricates & cools pipe and bit
- Affects hole stability

Drilling Fluid Types

- **Water based muds** are freshwater based with clay and other benign chemicals and are used usually for surface holes.
- **Oil based muds** are an inverted emulsion that is 80% base oil and 20% saturated salt water. These muds also contain clays and stabilizing chemicals that maintain the emulsion and prevent the water from reacting with the rocks.
- **Air/Foam** is used when the rocks are dry and relatively shallow.

Mud circulates through many pieces of equipment on a drilling rig

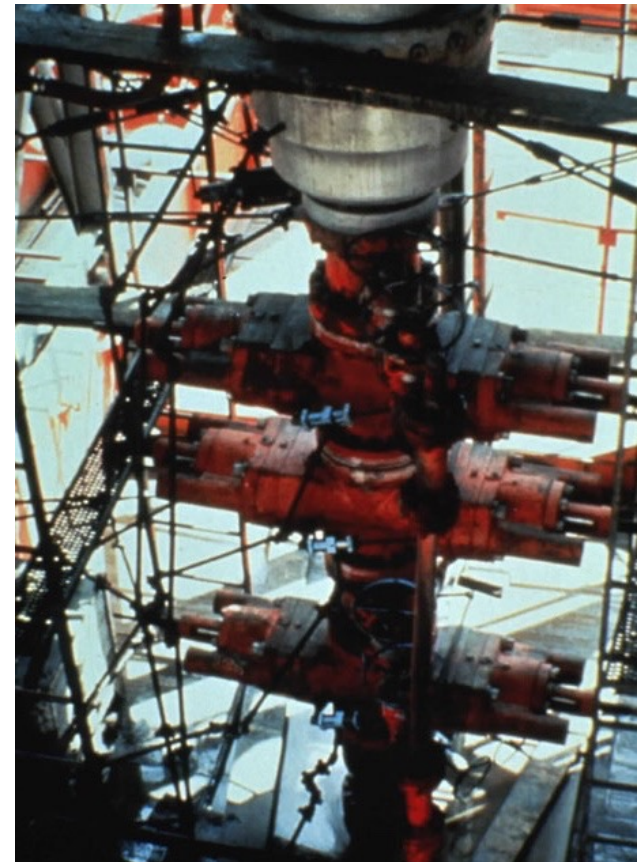


Well Control Equipment

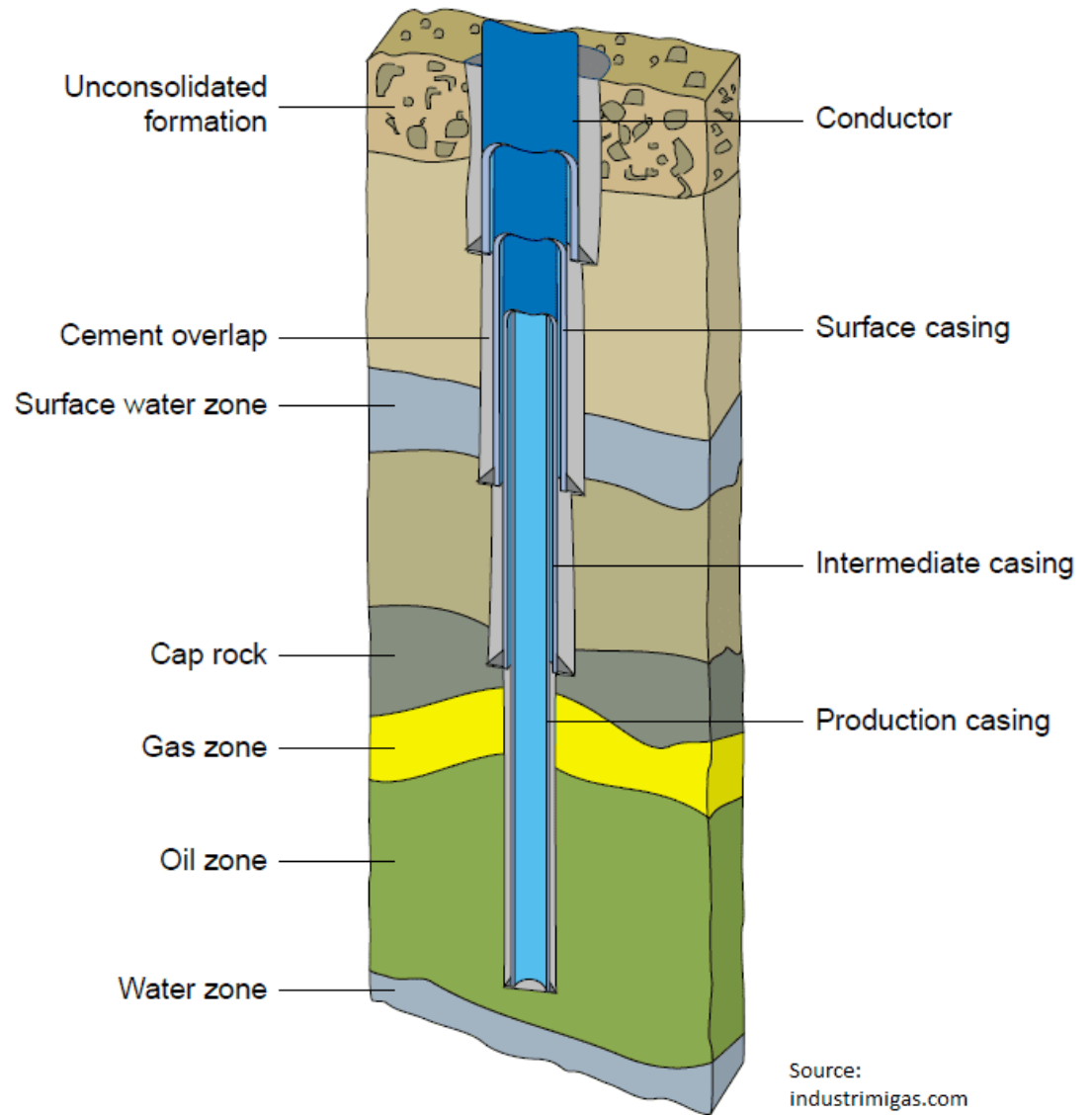
- BOP - blow out preventers
 - Annular
 - Ram
- BOP stack - BOPs stacked up
- Nipple up - attaching the BOP to the well head under the substructure in the cellar.

BOP Stack

- This land-based stack is nipped up on top of the well, and rises high in the substructure
- The higher the expected pressure, the taller the BOP Stack

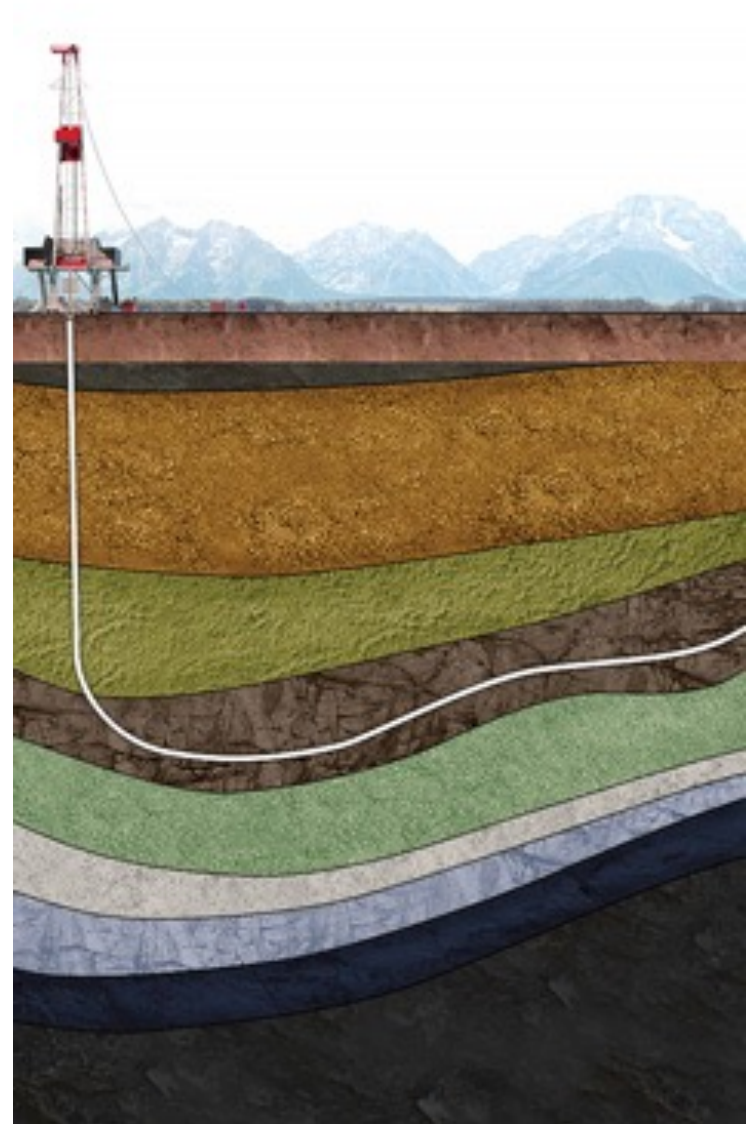


Typical Onshore Wellbore Schematic

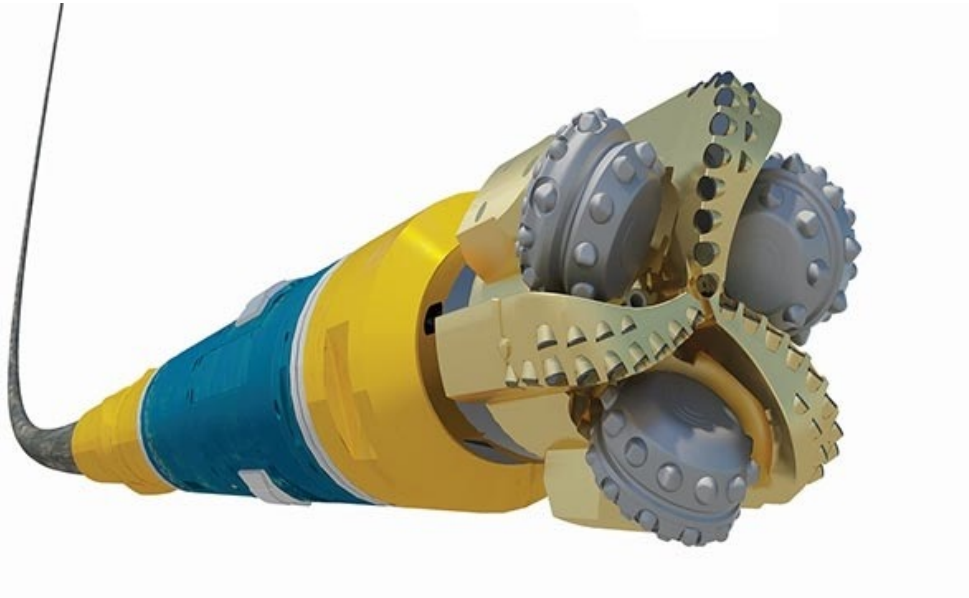


Horizontal Drilling

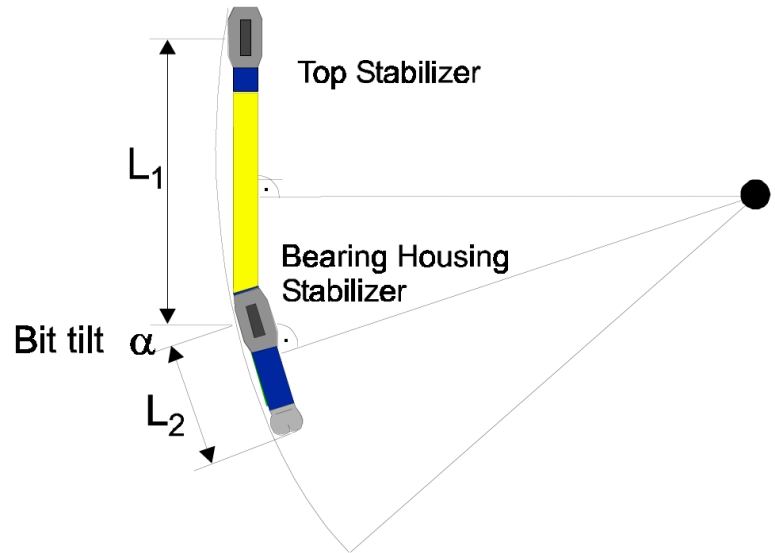
- More shale reservoir contact for multistage hydraulic fracturing
- Laterals can extend up to 5 miles



Directional Drilling Tools



Rotary Steerable Systems



Motor Steerable Systems

Formation Evaluation

- Physically look at chips of rocks for tell tale signs
- Mud loggers measure background gas coming from mud
- Mud color, florescence, smell



