Introduction to Petroleum Engineering

Drilling Rig types, main components

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Drilling Rig types, main components

- Extraction of oil and gas from a subsurface formation requires access to the resource. Drilling is one step in that direction. So, Reservoir fluids are accessed by drilling a well and then preparing the well for the production or injection of fluids.

- Expenditure for drilling represents a large fraction of the total project's capital expenditure (CAPEX) (typically 20–60%), therefore an understanding of the techniques, equipment and cost of drilling is important.

- Rig: the derrick, drawworks, rotary table and all associated equipment required to drill a well.

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Drilling Rig types, main components

- **Usually, wells are drilled with one, or a combination, of the following objectives:**
  - to gather information
  - to produce hydrocarbons
  - to inject gas or water to maintain reservoir pressure or sweep out oil
  - to dispose of water, drill cuttings or CO2 (sequestration)

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Drilling Rig types, main components

❑ First commercial oil well

- The first commercial oil well in Titusville, Pennsylvania, was drilled with a cable tool rig.
- Cable tool rigs lift and lower a bit to pound a hole in rock formations.
- As needed, pounding would be stopped so water and debris could be bailed from the hole with a “bailer” on a cable.
- And then the pounding resumed.
- Cable tool rigs could routinely drill from 25 ft per day up to 60 ft per day.
- Cable tool drilling, which is also known as percussion drilling, was used for all US fields in the 1800s.

but this method is slow

- It does not prevent unstable rock from collapsing into the wellbore.
- It does not effectively control subsurface pressure.
- Consequently, the uncontrolled production of fluids, known as a blowout, was common.

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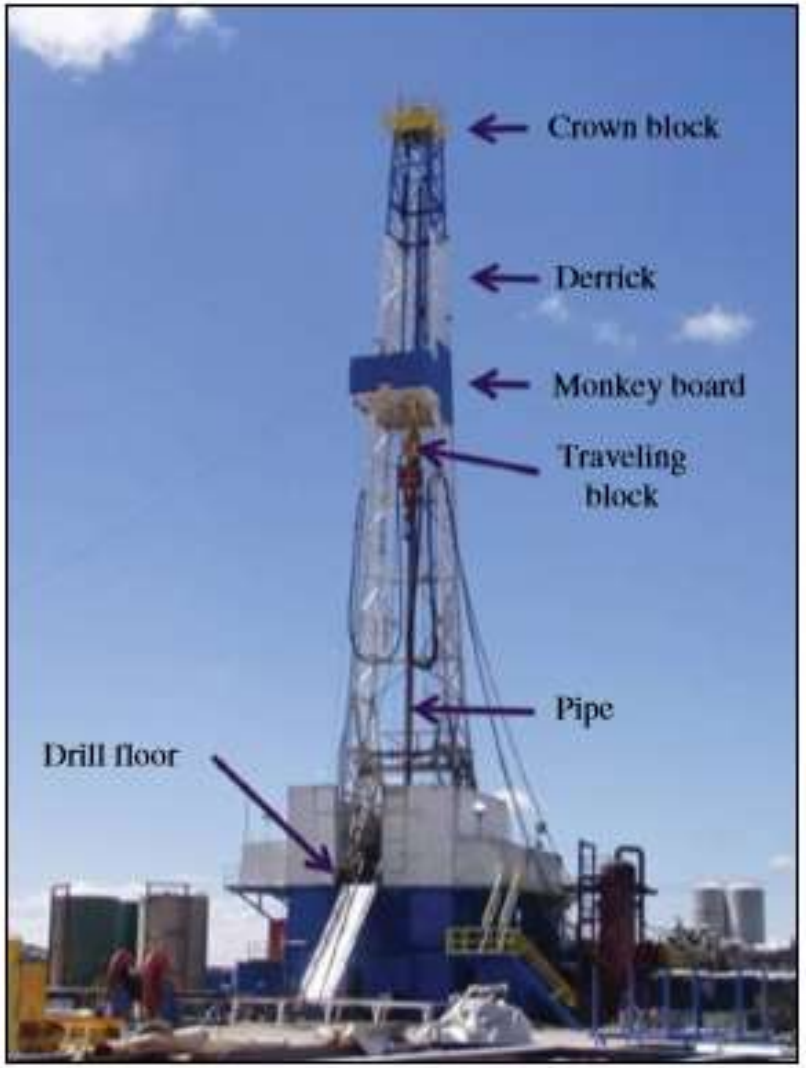
Drilling Rig types, main components

- **Rotary drilling** was introduced in the late nineteenth century and became the primary drilling method by the early twentieth century.



1. **Onshore rigs** can either be
   - moved in pieces and assembled on location.
   - or mounted on a truck.

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Drilling Rig types, main components

- **Rotary drilling** was introduced in the late nineteenth century and became the primary drilling method by the early twentieth century.

2. Offshore rigs

Semi-submersible rig

Jack-up rig

Drill ship

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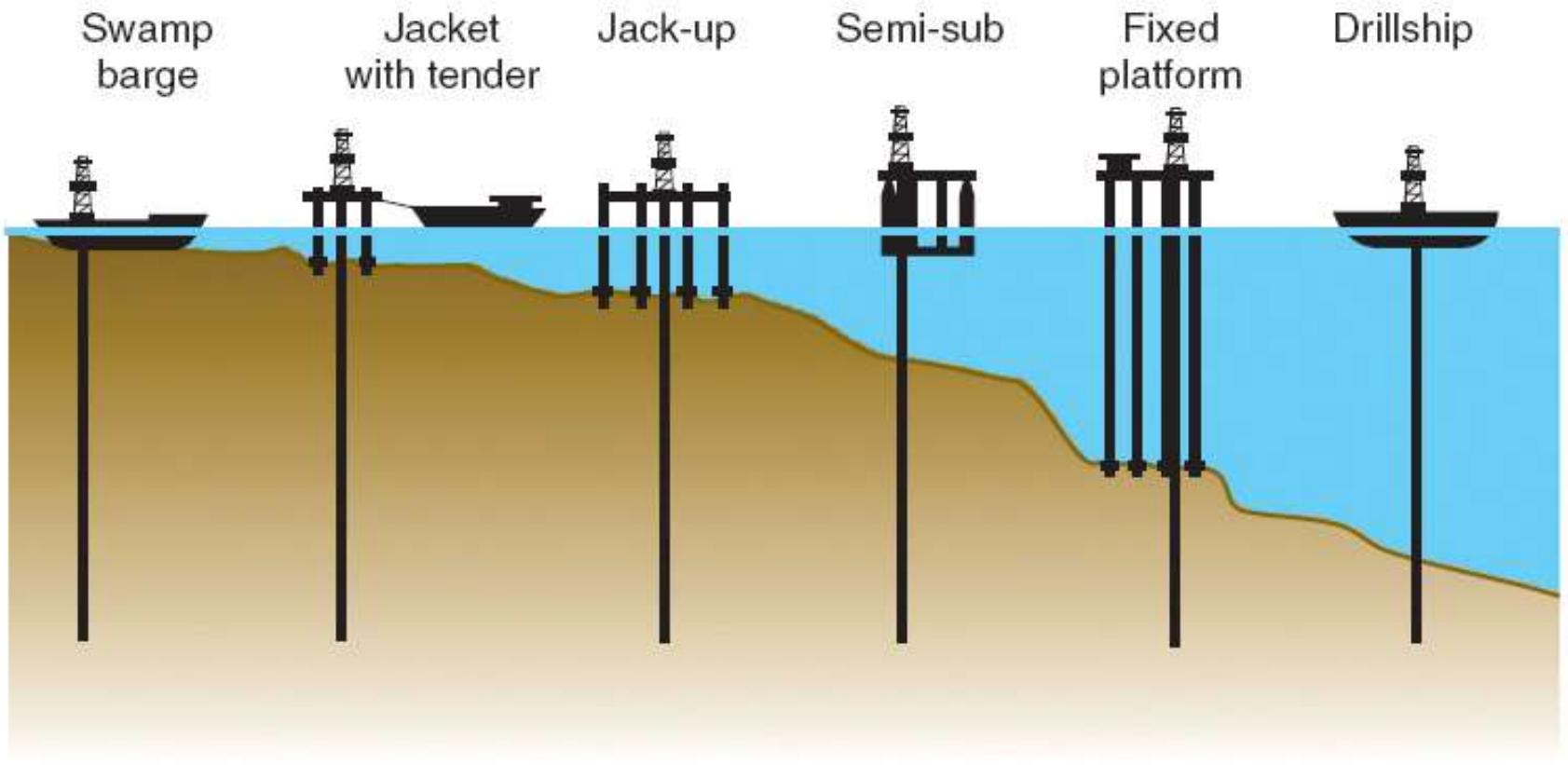
Drilling Rig types, main components

- **Rotary drilling** was introduced in the late nineteenth century and became the primary drilling method by the early twentieth century.

Offshore rig types



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Drilling Rig types, main components

- **Offshore rig types**

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Drilling Rig types, main components

- **The size of a rotary rig** depends on
  - The weight.
  - And power requirements associated with the depth of the well. A larger rig is used for a deeper well.
- **Offshore rigs** come in different forms depending on water depth, for example.
  - Barges can be used for shallow water or swamps.
  - Jack-ups can be used in water that is relatively shallow to a few hundred feet of water.
  - Semisubmersibles are used in a couple thousand feet of water.
  - Drillships are used in several thousand feet of water.

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Drilling Rig types, main components

- **Rig Selection:** The type of rig which will be selected depends upon a number of parameters, in particular:
  - Cost and availability.
  - Water depth of location (offshore).
  - Mobility/transportability (onshore).
  - Depth of target zone and expected formation pressures.
  - Prevailing weather/metocean conditions in the area of operation.
  - Experience of the drilling crew (in particular the safety record!).

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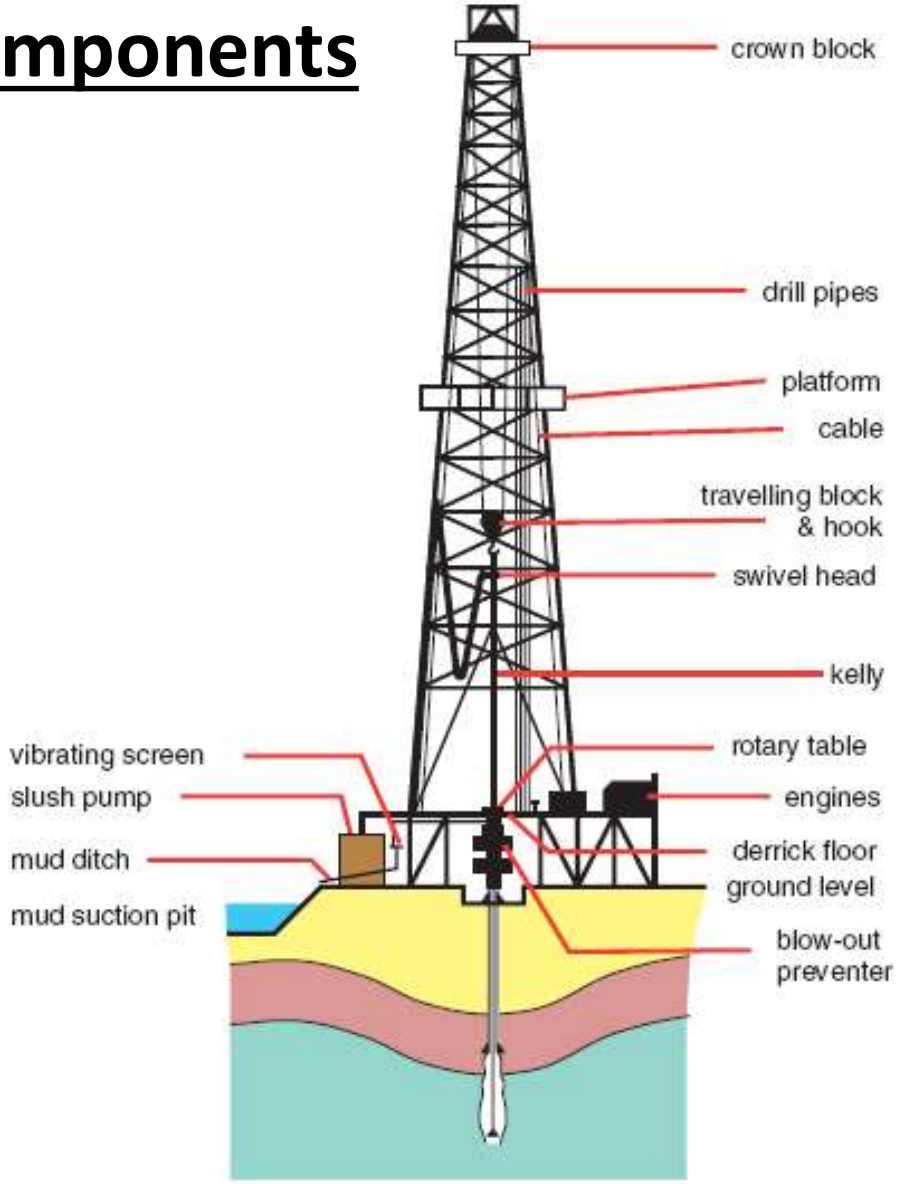
Drilling Rig types, main components

- **A rotary rig has several systems:**

1. A power system.
2. A hoisting system to raise and lower the drill pipe.
3. A circulation system to circulate drilling fluid or “mud”.
4. A rotation system to rotate the drill pipe.
5. In addition, a rotary rig has a system for controlling the well during emergencies.



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Drill String, main components

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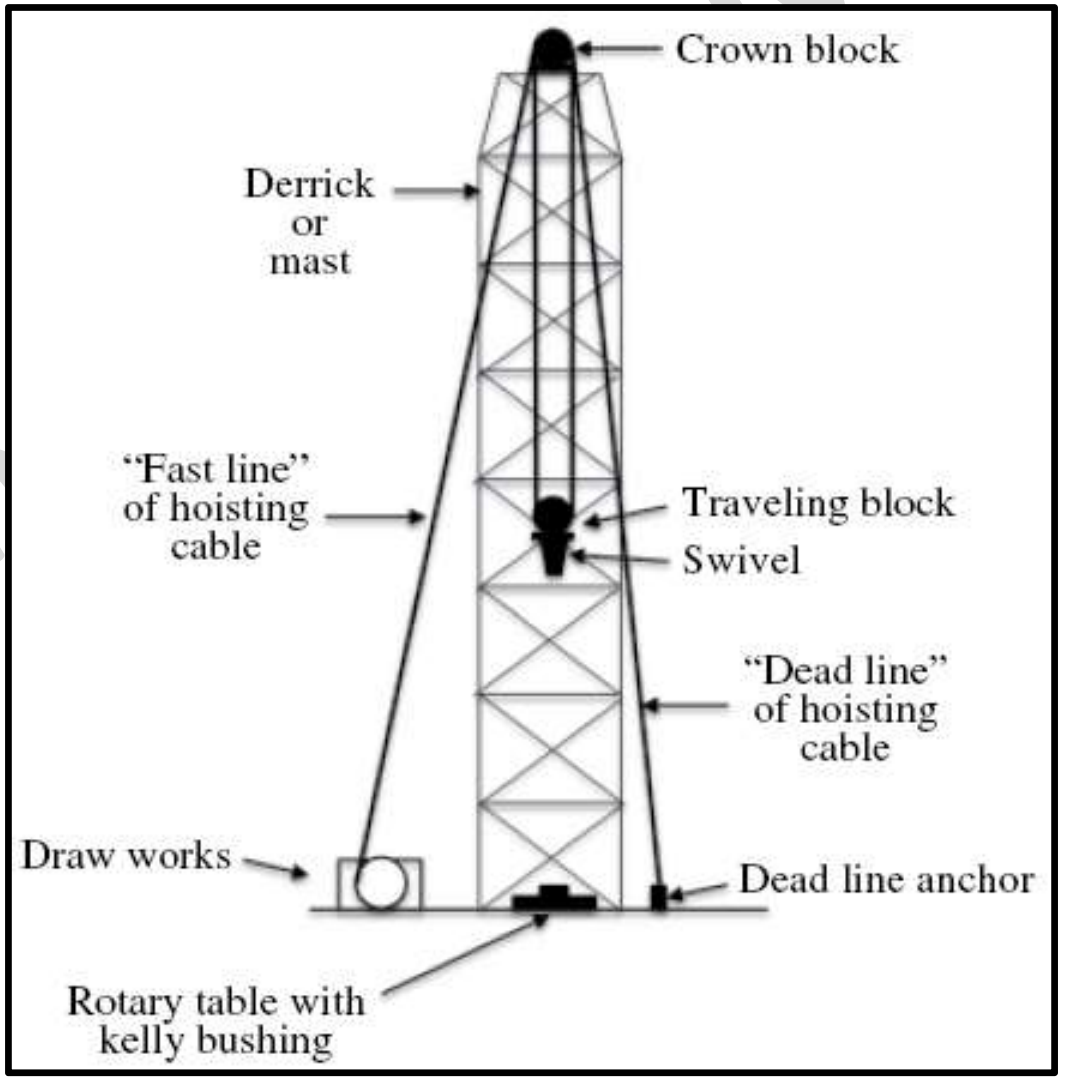
Drill String, main components

- **A hoisting system**

The hoisting system is used mostly to move the **strings of drill pipe** or casing up and down in the wellbore.

Illustration of the hoisting system



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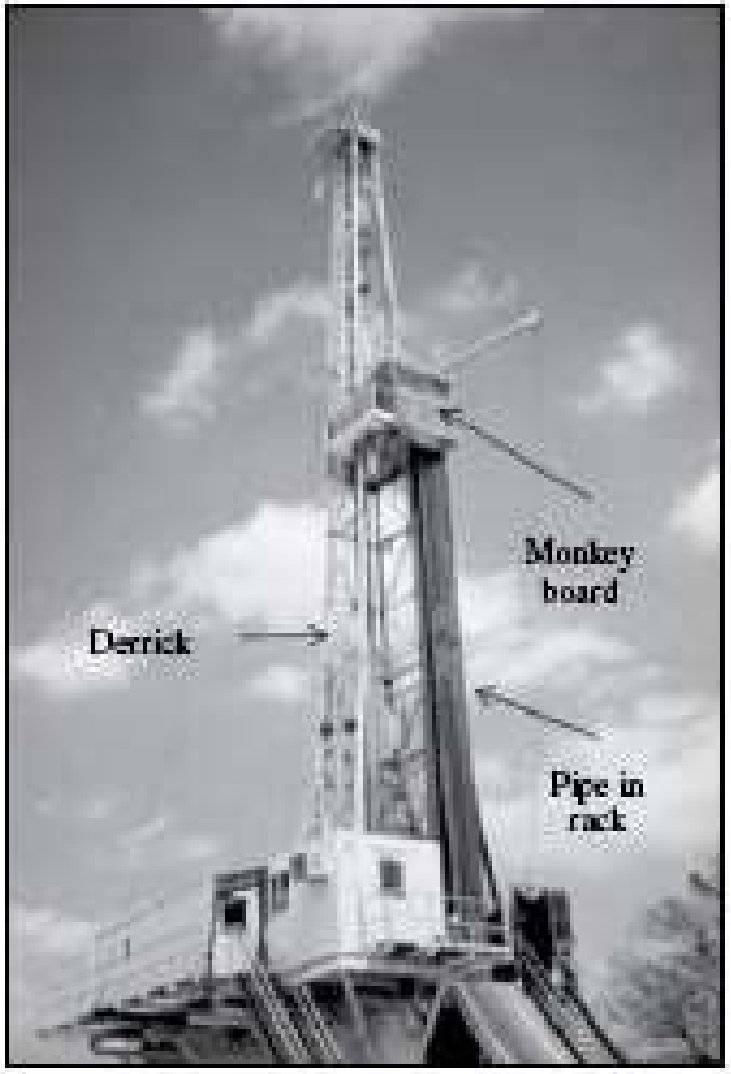
Drill String, main components

- **A hoisting system**

To repair or replace parts of the drill string, the crew must hoist, or "trip," it out of the hole. During a trip, stands of pipe are stored between the derrick floor and the monkey board. The monkey board is where the derrickhand is stationed to guide the pipe. A stand of pipe is two or three pipe joints that are screwed together.

Derrick with pipe in rack



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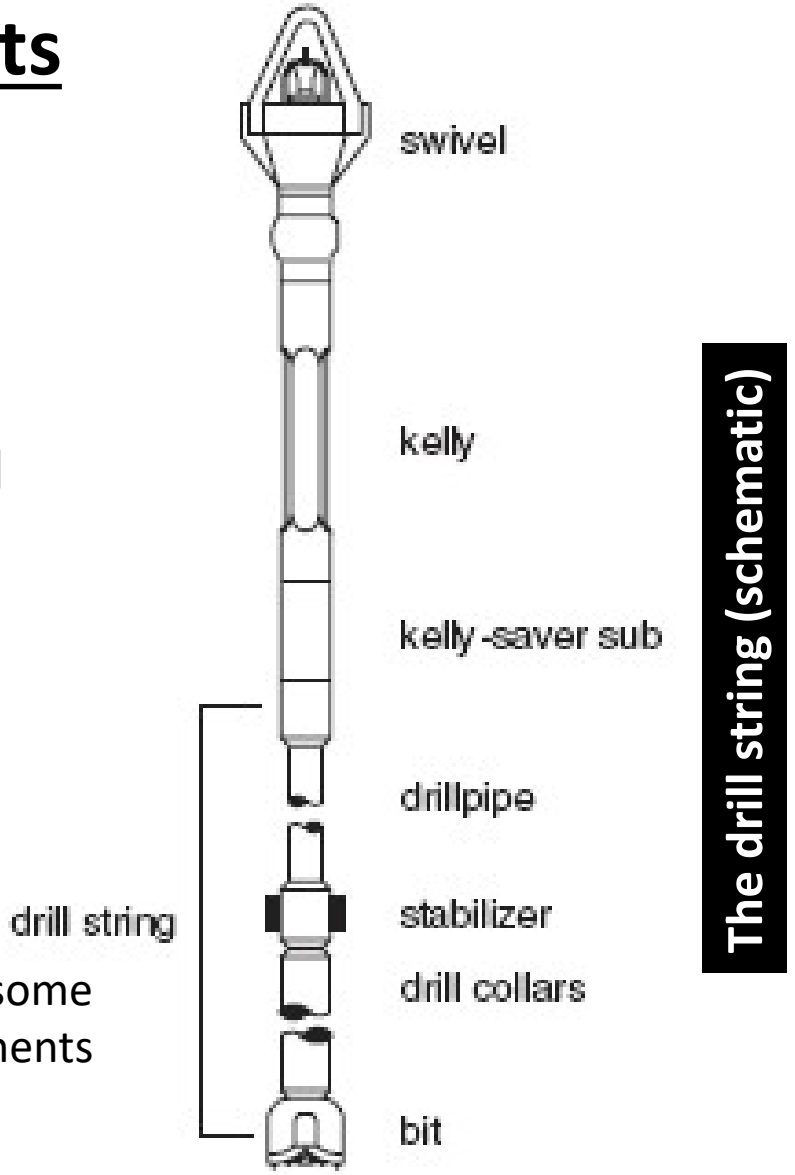
Drill String, main components

- **The drill string consists of:**
  - **Drill pipes**
  - **Drill collars**
  - **Drill bit**
  - **And optional attachments**

- **Drill stem**: used in place of drillstring in some locations. Describes all the drilling components from the swivel down to the bit.



The drill string (schematic)

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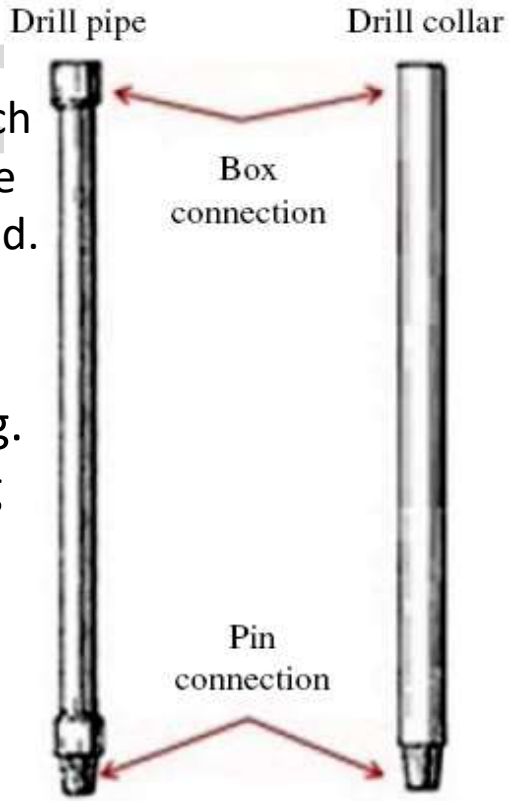
Drill String, main components

- **The drill string consists of:**



- **Drill pipe:** is the major component of the drill string, which forms the upper part of the drill string. It is a seamless pipe which is used to rotate the bit and circulate the drilling fluid.

- **Drill collars:** are heavy-walled drill pipes that
  - place weight on the drill bit during actual drilling.
  - keep the drill pipe in tension to prevent bending and buckling of the drill pipe.

Drill pipe and collars are rated by

- Size (outer diameter).
- Weight per unit of length.
- Grade (steel material and manufacturing process).
- Connections.

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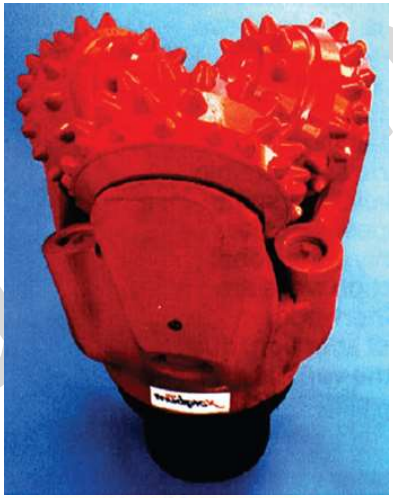
Drill String, main components

- **The drill string consists of:**
  - **Drill bit:**
    the cutting element at the bottom of the drillstring, used to grind, break, or shear the rock at the bottom of the well.

Rotary bits are either

- **Roller-cone**.
- Or **drag bits**.



Roller cone bit

Drag (PDC) bit

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Drill String, main components

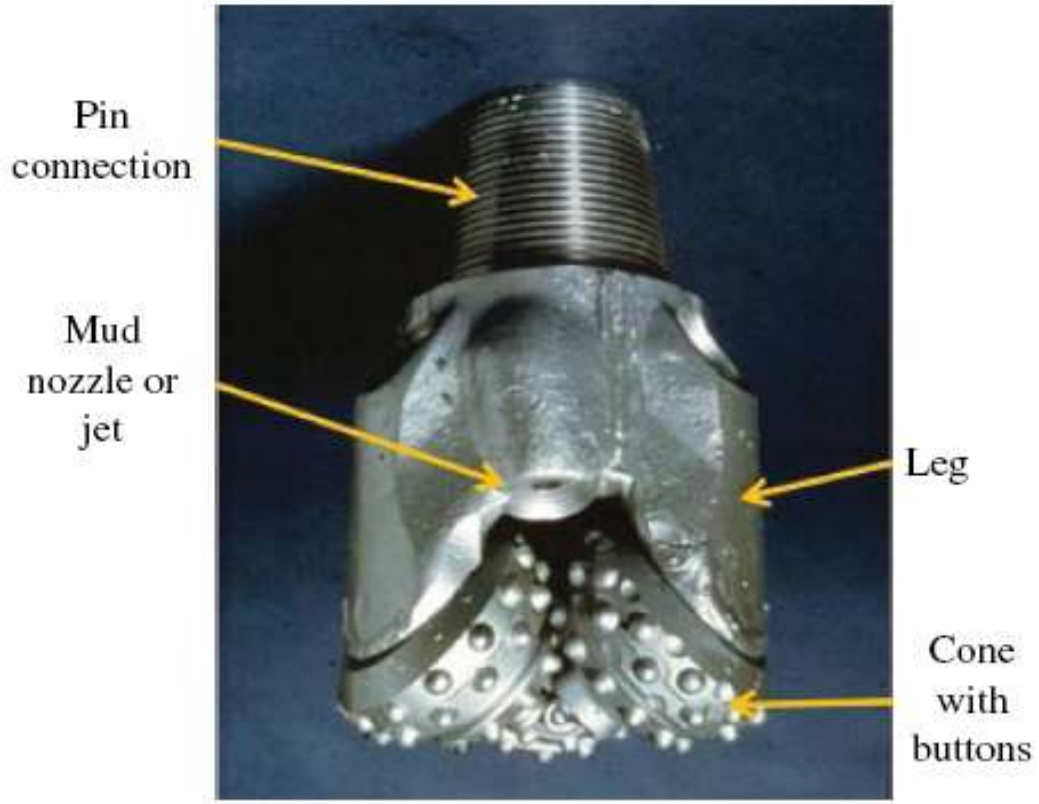
❑ **The drill string consists of:**

➢ **Drill bit:**

Materials used for cutting surfaces of bits depend on what type of formation the drill bit will encounter. **1. Roller-cone bits** can have

➢ Steel teeth
(softer formations).

➢ Tungsten carbide buttons
(harder formations).



Roller cone (tricone) bit

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Drill String, main components

- **The drill string consists of:**

  - **Drill bit:**

Materials used for cutting surfaces of bits depend on what type of formation the drill bit will encounter. **2. drag bits** can have

- PDC discs bonded to tungsten carbide posts mounted on the surface of a bit. PDC bits are good for drilling hard formations.

- Diamond-impregnated bits have whole diamonds bonded to the surface of a bit. These bits can be used for the hardest formations.

Polycrystalline Diamond Compact (PDC) bit

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Drill String, main components

- **The drill string consists of:**
  - **And optional attachments:** may include

Stabilizers

Jars

Shock subs, etc.