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Course outline –Applied Petroleum Geology

4th Year BS (Hon.) Department of Geology & Mining, University of Barishal.

1) ***Fundamentals of petroleum exploration drilling:***

Drilling rigs- onshore and offshore rigs;

Component systems of rotary drilling rigs –

Rotating system-

Hoisting system-

Mud circulation system-

BOP system

2) Mud logging and Well site geology:

Drilling mud- uses of drilling mud

Drilling data, mud data, cutting data.

3) Wireline logging and Formation Evaluation:

Caliper log,

Electrical log (Resistivity and SP),

Gamma ray log,

Sonic log, Density log, Neutron log.

Interpretation of wireline logs,

Use of wireline logs in hydrocarbon detection.

4) Drill stem testing (DST) and well completion.

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5) Blowout accident in petroleum exploration drillings:

Definition of blowout

Causes of blowout

How to handle a blowout

Case study- Maulvibazar gas well blow out,

Tengratila (Chattak) gas well blowout

6) Habitat of Petroleum in Bangladesh:

Petroleum geological provinces in Bangladesh;

Petroleum prospects and hydrocarbon plays in different provinces-- source rock, reservoir rock, trap and migration.

Undiscovered petroleum gas resources in Bangladesh

7) A review of petroleum geology of adjacent India

Assam,

West Bengal and Tripura

Myanmar.

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Drilling Rig

The machine used to drill a wellbore.

In onshore operations, the rig includes virtually everything except living quarters. Major components of the rig include the mud tanks, the mud pumps, the derrick or mast, the drawworks, the rotary table or topdrive, the drillstring, the power generation equipment and auxiliary equipment.

In Offshore, the rig includes the same components as onshore, but not those of the vessel or drilling platform itself. The rig is sometimes referred to as the drilling package, particularly offshore.

A drilling rig is used to drill a hole, and this requires qualified personnel, different types of equipment the application of a great variety of technology.

When a drilling project is commenced, two goals must be achieved:

- To drill and finish the well in a safe manner (personal injuries, technical problems) and according to its purpose;
- To complete the project with minimum cost.

The overall costs of the well must be optimized and this optimization may influence where the well is drilled (onshore – extended reach or offshore above reservoir), the drilling technology applied (conventional or slim-hole drilling) as well as the evaluation procedures run to gather subsurface information for future drilling projects.

Rotary drilling is the most efficient technology applied in the oil and gas industry.

It is a drilling technology that relies on continuous circular rotation of the bit to break rocks, while drilling fluids circulate through the bit and up the wellbore to the surface, making possible to drill safely and efficiently the well.

Offshore Vs. Onshore Oil Drilling

Oil drilling falls into one of two main categories: **offshore and onshore**. The location of the drilling is the most obvious difference, but the two types vary in other areas, including cost, profits, timelines for drilling and processes.

Both types of drilling have certain advantages over the other, but both are actively used to extract oil to meet the high demands of the world. When you learn how to invest in oil, understanding the differences between onshore and offshore drilling helps you make decisions about your investments a little easier.

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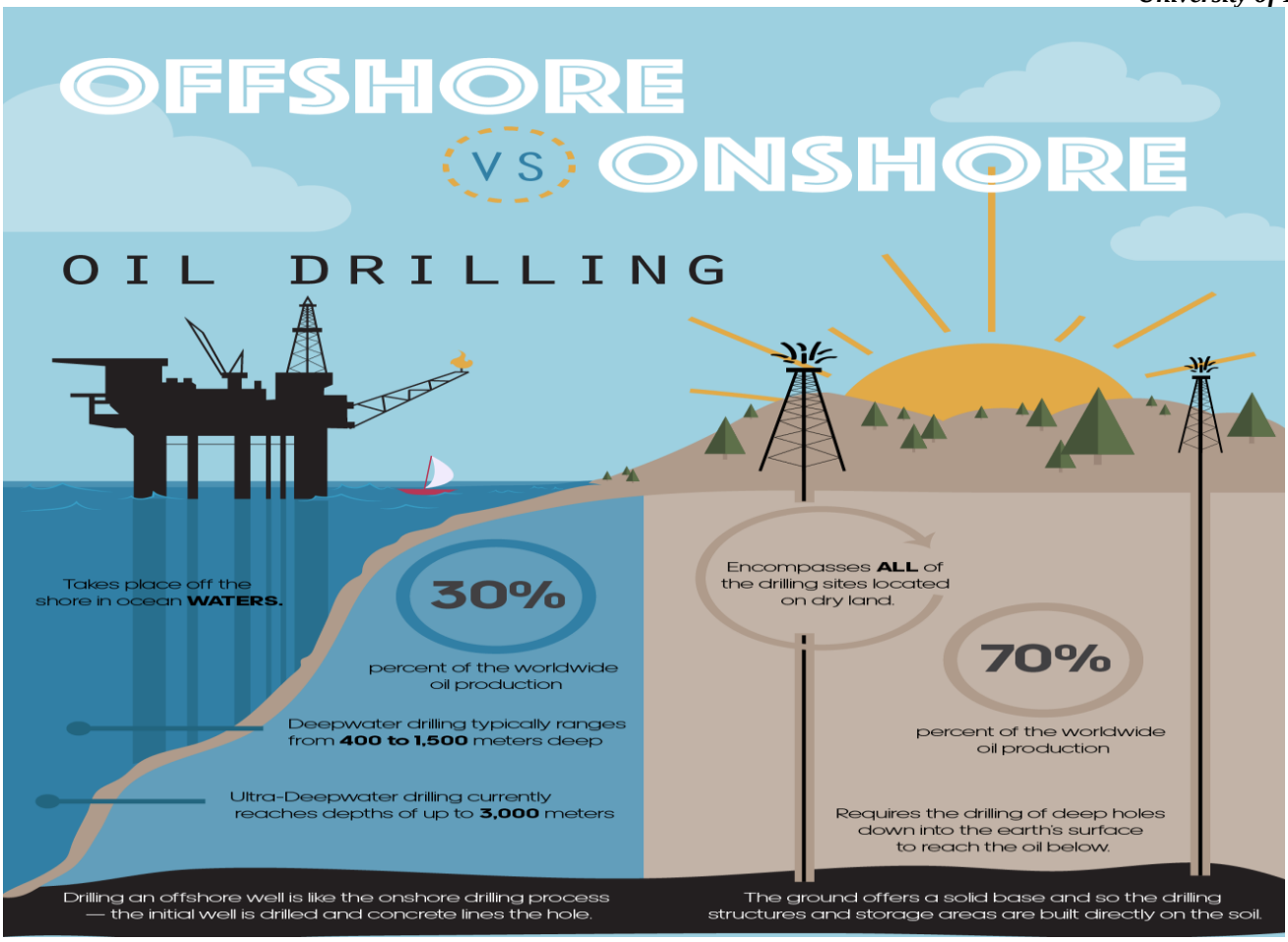
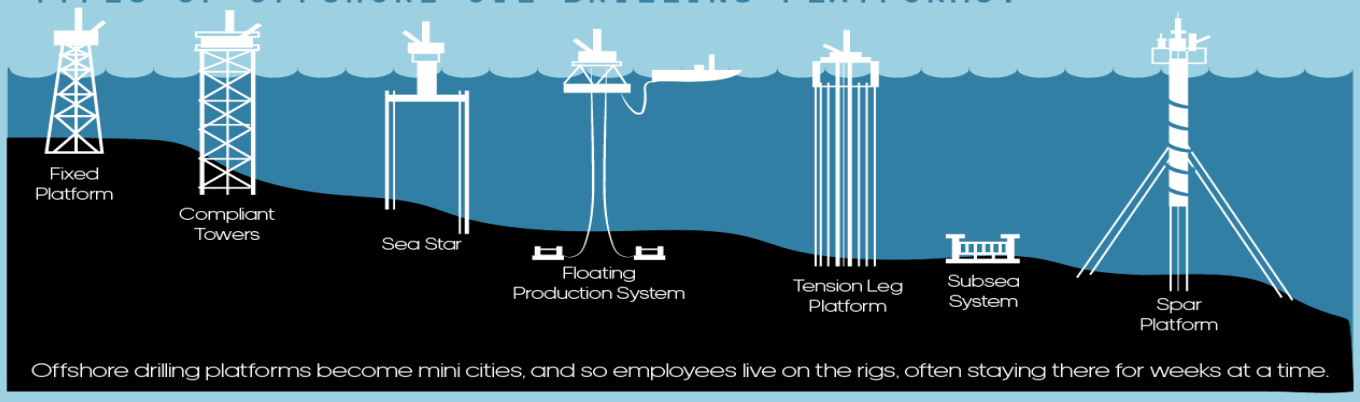


EQUIPMENT DIFFERENCES:

- A major difference for offshore drilling is the need for **STABILITY.**
- Offshore drilling presents much more of a challenge due to the shear **DEPTH** of the water to reach the earth's surface.
- The force of the rough waters requires a **MANMADE** working surface to hold the drilling equipment and facilities with some type of anchoring to the ocean floor.

- Onshore wells **DON'T REQUIRE AMENITIES** or features and employees can report to work for the day and return home at night.

TYPES OF OFFSHORE OIL DRILLING PLATFORMS:



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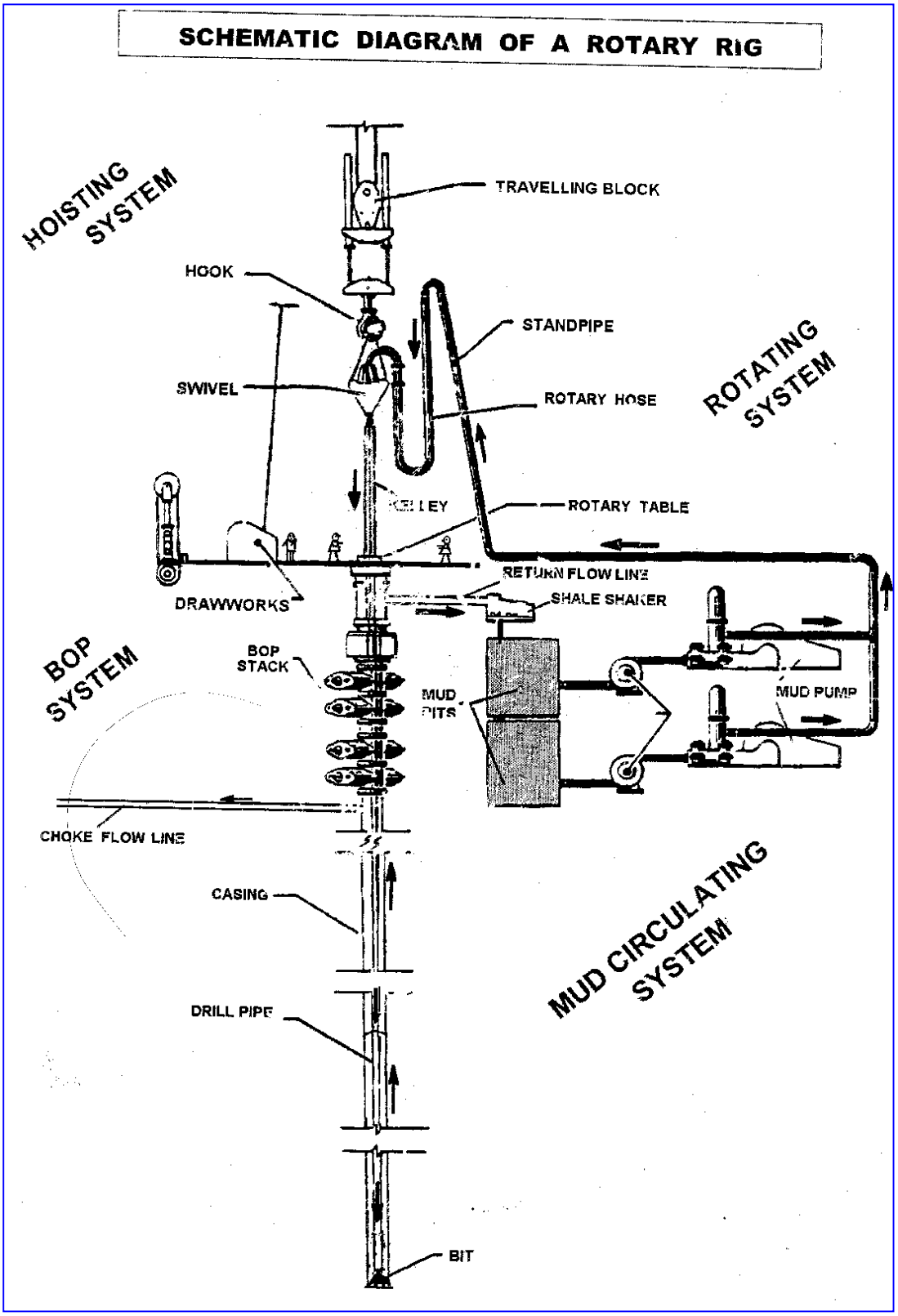
Rotary drilling rig

The drilling rig consists of a set of equipment and machinery located on the so-called drilling site and normally the rig is not owned by the oil company but by drilling service companies, which hire out the rig complete with operators and which construct the well according to the client's specifications.

The most important items of equipment are shown in the figure below.



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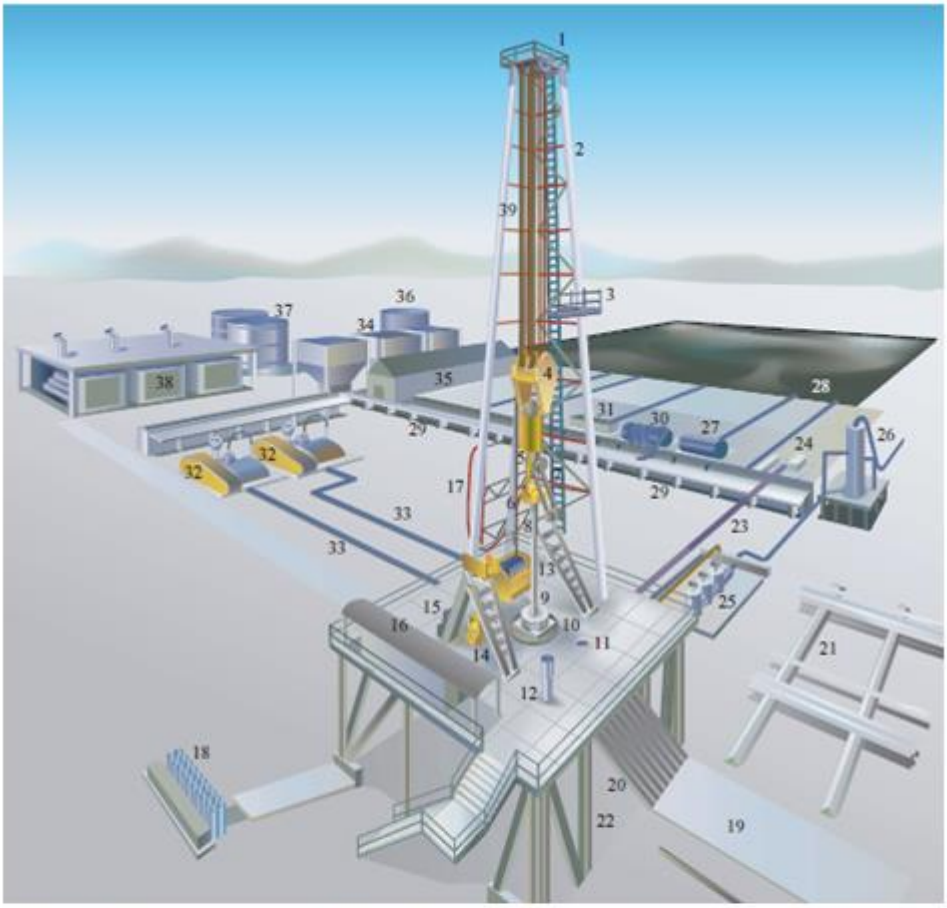

1 crown block	14 weight indicator	27 degasser
2 mast	15 driller's console	28 reserve pit
3 monkey board	16 doghouse	29 mud pits
4 traveling block	17 rotary hose	30 desander
5 hook	18 accumulator unit	31 desilter
6 swivel	19 catwalk	32 mud pumps
7 elevators	20 pipe ramp	33 mud discharge lines
8 kelly	21 pipe rack	34 bulk mud components storage
9 kelly bushing	22 substructure	35 mud house
10 master bushing	23 mud return line	36 water tank
11 mousehole	24 shale shaker	37 fuel storage
12 rathole	25 choke manifold	38 engines and generators
13 drawworks	26 mud gas separator	39 drilling line

A drilling rig is composed of different systems:

- ***The hosting system***
  - It the set of equipment necessary for handling any material inside the well(drill string and the casing);
  - It consists of a structural part (derrick/mast and substructure), the complex of the crown and travelling block, the drawworks (hoist) and the drilling line;
  - The substructure is the supporting base for the derrick, the drawworks and the rotary table, and constitutes the working floor for operations, or drilling floor.

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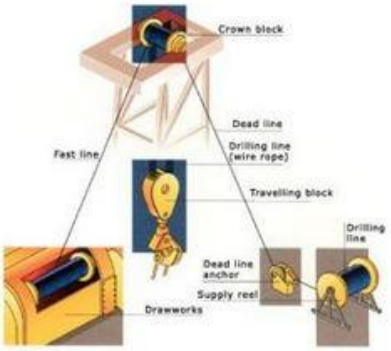

The Hosting System

The Derrick Types

The Mast Types

- ***The rotating system***
  - The rotating system allow the rotation of the drill string, and it consists of the rotary table, the kelly and the swivel;
  - In modern rigs, a *top drive* groups together the functions of the above three items of equipment.

The Kelly System

The Top Drive System

- ***The circulation system***
  - The circulation system consists of mud pumps, distribution lines, and the mud cleaning and accumulation system;
  - It is the closed hydraulic circuit which allows the mud to flow from the surface to the bottom of the hole, inside the drill string, and subsequently back to the surface, in the drillstring borehole annulus;
  - The mud from the hole has to have the cuttings removed before being reinjected to the bottom of the hole and the mud pumps supply the energy necessary for circulation;
  - The choice of drilling fluid is dictated mainly by the characteristics of the formations to be drilled, by their drillability and reactivity to water, and by problems of disposing of the spent fluid;
  - Drilling fluids have many functions to perform including:

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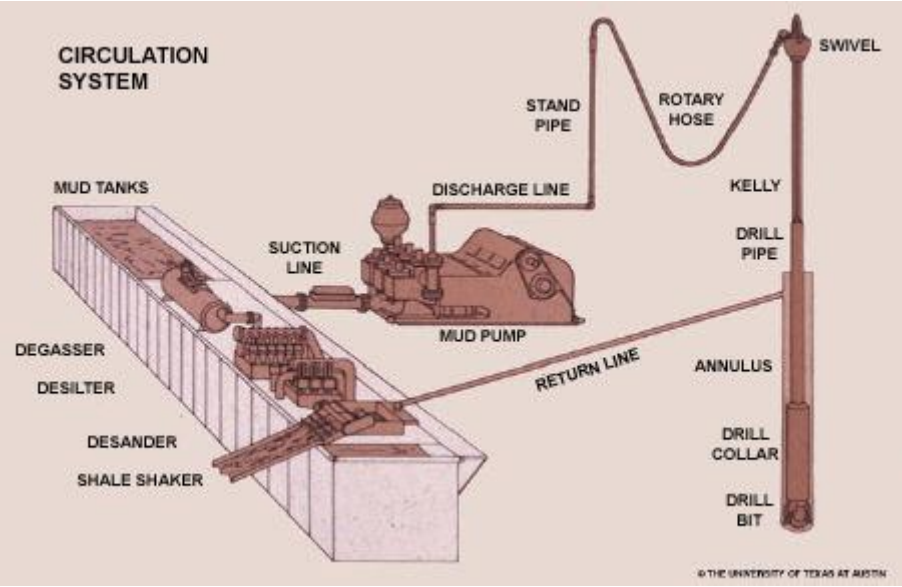
- *The removal and transport to the surface of the cuttings produced by the bit;*
- *The control of the formation pressure;*
- *The prevention of caving and collapse of the borehole walls;*
- *The slowing down of the sedimentation of the cuttings when circulation stops;*
- *The cooling and lubrication of the drilling equipment;*
- *The sources of geological and stratigraphic information.*

- Drilling fluids are subdivided into three major classes:
  - Water based muds;
  - Oil based muds;
  - Air -based muds (used to reduce bottomhole pressure, to avoid circulation losses in surface layers, or to limit damage to productive formations).



- ***The power generation system***
  - A power generation system is needed to run the machines driving the main components of the rig and it is provided by diesel engines, diesel-electric engines;
  - Power is transferred from the engines to the different rig systems by belts, chains, and drive shafts on a mechanical rig, or by generated DC electrical power on an electric rig and it is distributed to the rotary table and mud pumps and to the drawworks.

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The drill string

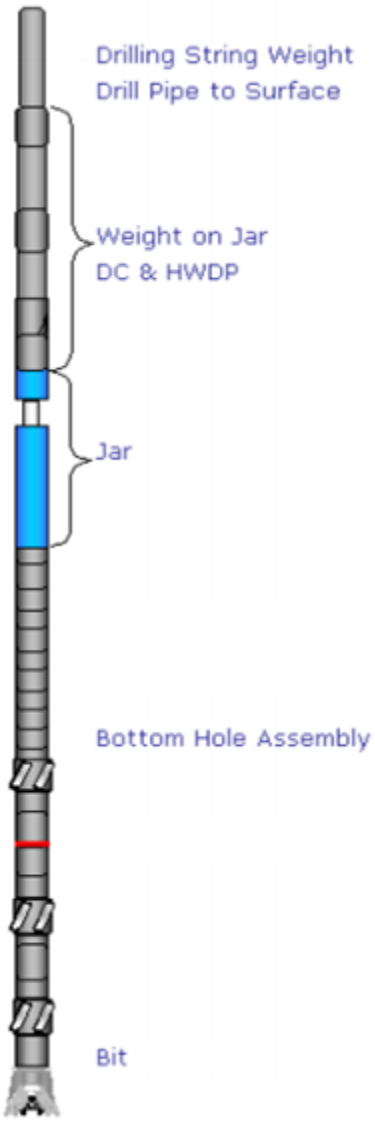
The drill string is an assemblage of hollow pipes of circular section, extending from the surface to the bottom of the hole.

It has three functions:

- it takes the drilling bit to the bottom of the hole, while transmitting its rotation and its vertical load to it;
- it permits the circulation of the drilling fluid to the bottom of the hole;
- it guides and controls the trajectory of the hole.

Starting from the surface, drill string consists of:

- a kelly, drill pipes, intermediate pipes, drill collars and a number of accessory items of equipment (stabilizers, reamers, jars, shock absorbers, downhole motors, etc.), and it ends with the bit;
- The bit is connected on to the end of the drill string – it is the tool that bores the rock, transforming it into fragments called *cuttings*, which are then transported to the surface by the drilling fluid;
- The choice of the type of bit depends on the hardness, abrasiveness and drillability of the rock formation.



An Insert Tricone Bit

A PDC Bit

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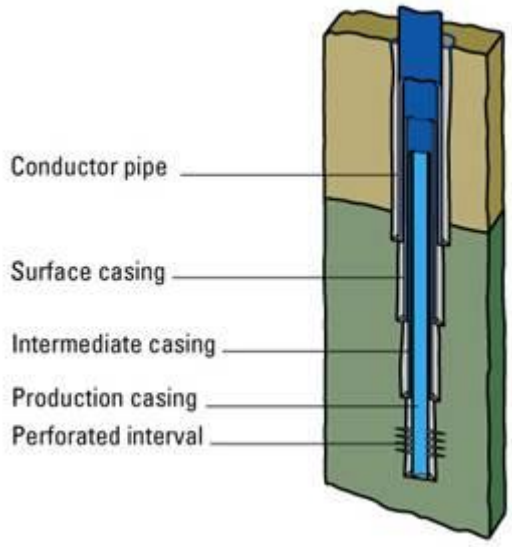
Casing

- Casing is a steel tube that starts from the surface and goes down to the bottom of the hole, and is rigidly connected to the rocky formation using cement slurry, which also guarantees hydraulic insulation.
- The casing supports the walls of the hole and prevents the migration of fluids from layers at high pressure to ones at low pressure.
- Furthermore, the casing enables circulation losses to be eliminated, protects the hole against damage caused by impacts and friction of the drill string, acts as an anchorage for the safety equipment (BOPs, Blow Out Preventers) and, in the case of a production well, also for the Christmas tree.
- The dimensions of the tubes, types of thread and joints are standardized (API standards)and the functions and names of the various casings vary according to the depth.
- Starting from the uppermost and largest casing, first comes the conductor pipe, then the surface casing and the intermediate casing, and finally the production casing.



Cementing

Cementing is the operation of pumping a cement slurry between the casing and the formation, and can be performed by injection into the annulus from inside the casing.

The cementing (primary cementing) serves to rigidly connect the casing to the formation and to guarantee the hydraulic insulation of the various formations, preventing the migration of the fluids from layers at high pore pressure to those at low pressure.

The centralization of the casing is particularly important, as the geometry of the well is seldom regular, but tortuous and with a variable diameter.

All other cementing operations carried out after the primary operation, either to correct an earlier not very effective cementing operation, or for other purposes (repair of a damaged casing, setting cement plugs, squeeze operations, and so on), are called secondary cementing.

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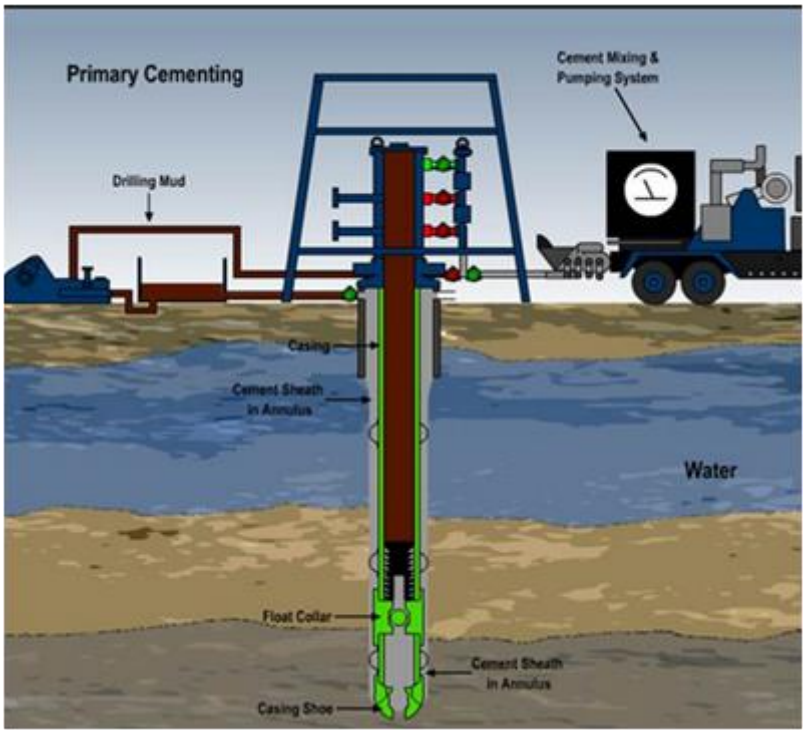

The wellhead and safety equipment (BOP)

The wellhead and the safety equipment are the valve units that allow the well to be insulated from the outside environment.

In this way it is possible to control effectively and safely the pressures that develop in the well when it is in hydraulic communication with the subsurface formations.

The wellhead is a fixed unit that connects the various casings set inside the well.

If it is a producing well, this unit remains there until the end of drilling, and is completed with the production head or Christmas tree.

The safety equipment, known as Blow Out Preventers (BOPs), are large valves located on the wellhead during drilling operations able to fully shut-in the well in case of need (Well control).

BOPs on onshore rigs and fixed offshore rigs (platforms, jack-ups) are installed on the surface wellhead, while for floating rigs they are located on the seabed, on the subsea wellhead.

The shut-in of the well is necessary when hydraulic control is lost, i.e. when the pressure of the underground fluids is greater than that of the bottomhole mud.

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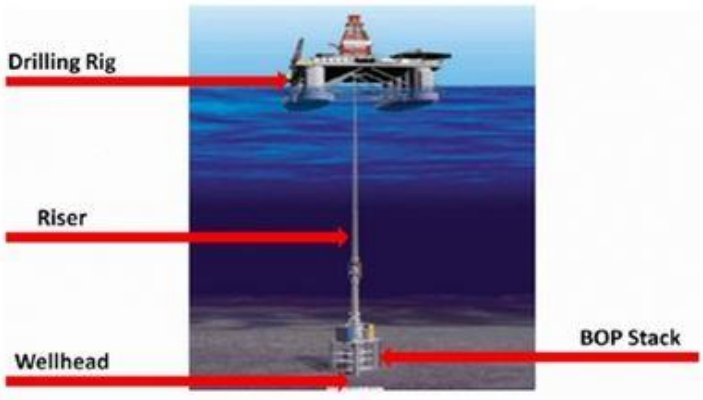
A standard BOP stack consists, starting from below, of:

- one or more spools for connection to the wellhead; a dual function ram preventer; a single-function ram preventer; an annular blowout preventer; a lateral tube, which conveys the outgoing mud from the well to the shaker; a number of lateral connections (*kill line* and *choke line*), necessary for operations to restore hydraulic balance after well control problems.

The BOP stack has the following functions:

- to shut-in the well around any type of equipment; to permit pumping of the mud, with the well closed by means of the kill line; to discharge through the choke line any fluids that might have accidentally entered the well; and to allow the vertical movement of the string, upwards or downwards, when the well is closed (*stripping*).

Land BOP Stack



A Subsea BOP Stack