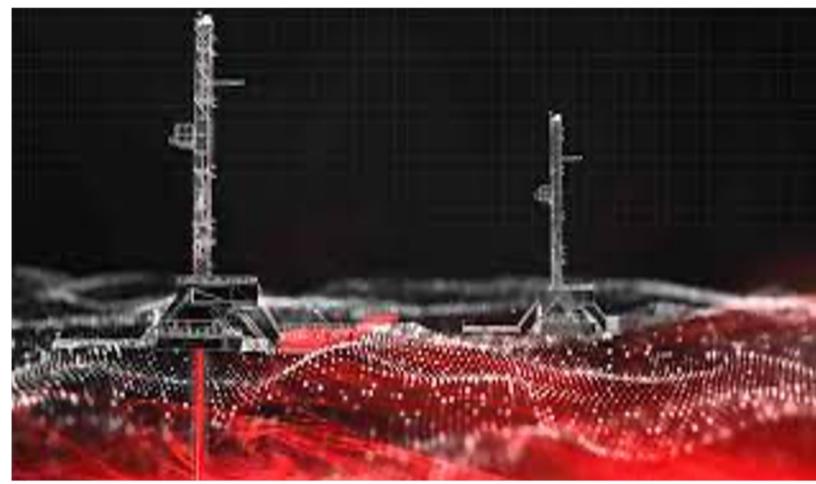


DRILLING ENGINEERING CONCEPTS

Drilling Engineering Concepts



Why Drill (Not the Only W?)

Resources – Drilling Rigs, people and Systems

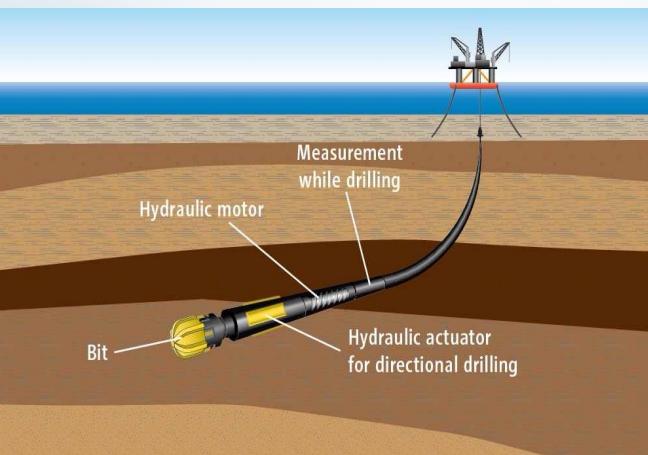
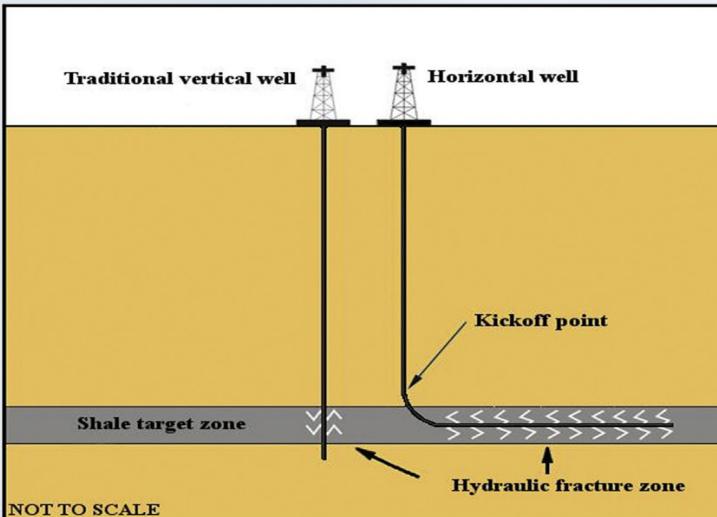
Consumables : Tubulars, Fluids, and Services

Services (Field Location) : Surveying, Logging, On Call

Services (Base Support) : RT Data and Supply Chain

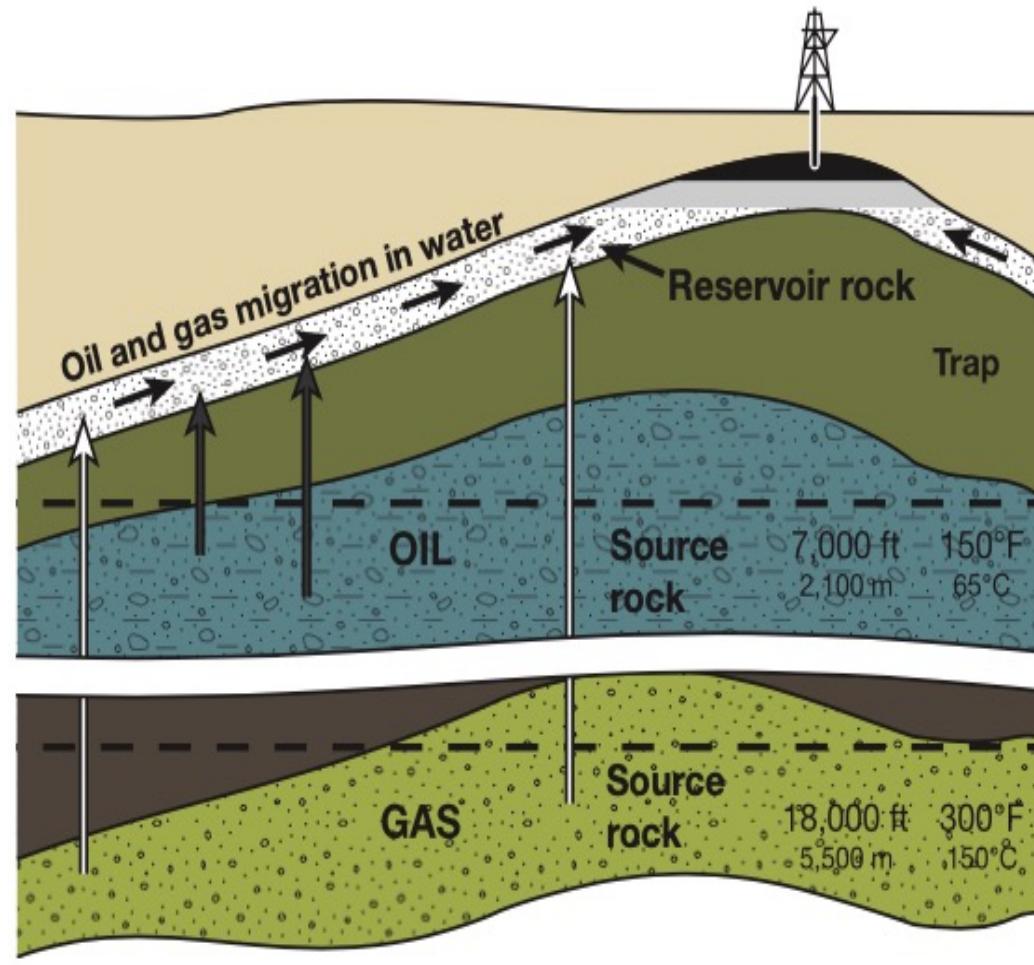
- A. Why Drill (not the only W ?)
- B. Types of Rigs
- C. Rig Systems
- D. BHA
- E. Casing
- F. Cementing
- G. Drilling Fluids
- H. Basic Logging
- I. Introduction to directional drilling

Why Drill ? (Not the Only W ??)



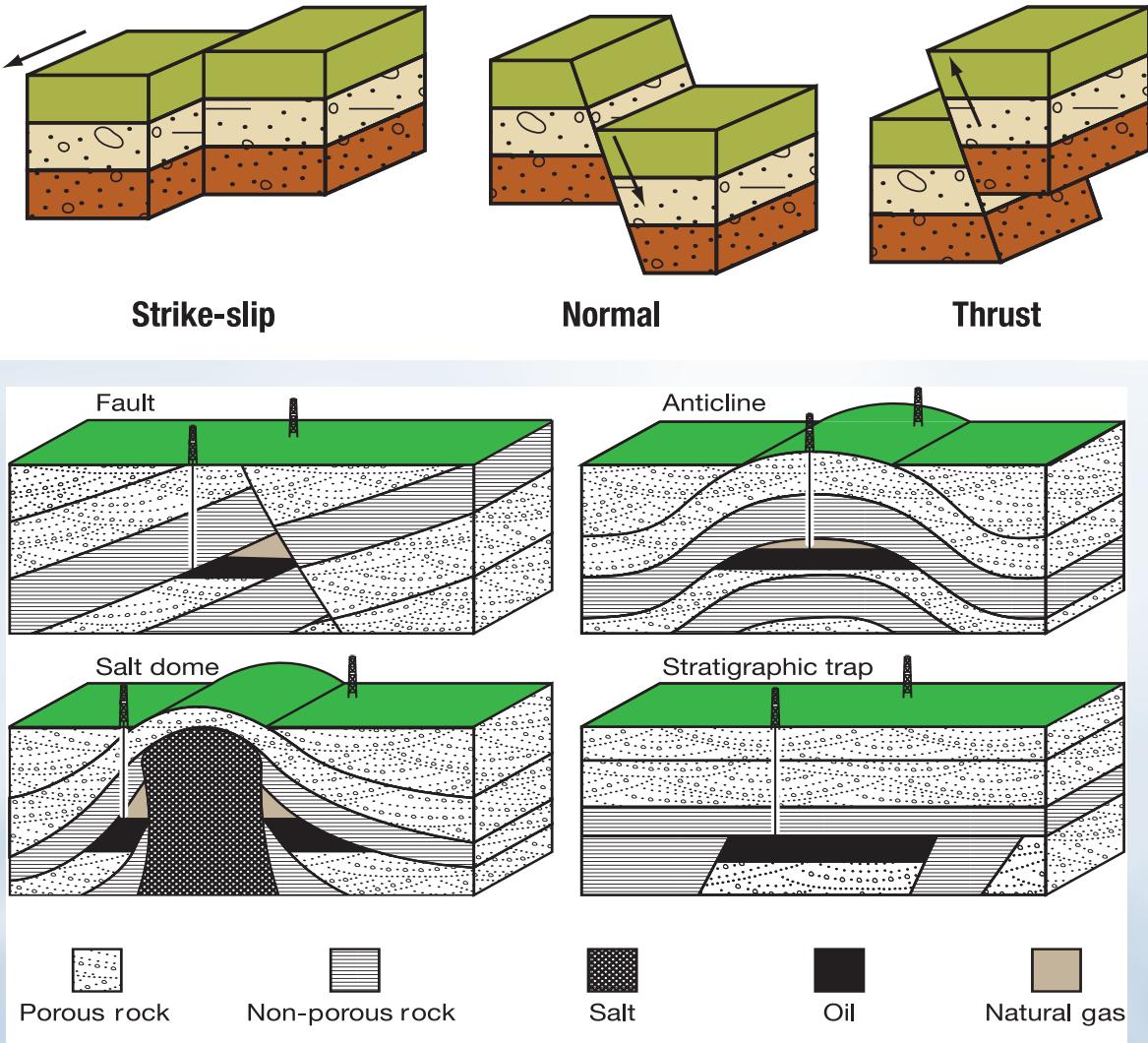
- ✓ Drilling here refers to making borehole (well) in the earth's upper crust (location) aimed to recover oil and / or gas (hydrocarbon) in commercial quantities.
- ✓ Drilling a well at location is the only process to "Confirm" availability of commercial quantities of producible Hydrocarbon stored in mother earth's reservoirs (formation).
- ✓ Although above may sound simple, drilling wells can be quite challenging as it involves complex process even for a typical vertical well to variety of geometrical profiles.
- ✓ Costs of drilling vary widely and can be from one million to well over 100 millions based on depth, location, and resources used.
- ✓ Resources such as rental equipment, consumables, and services such as providing manpower and special supports also change very widely based on process of drilling / technique utilized, location, and of course objectives.

...When, What and Where To Drill



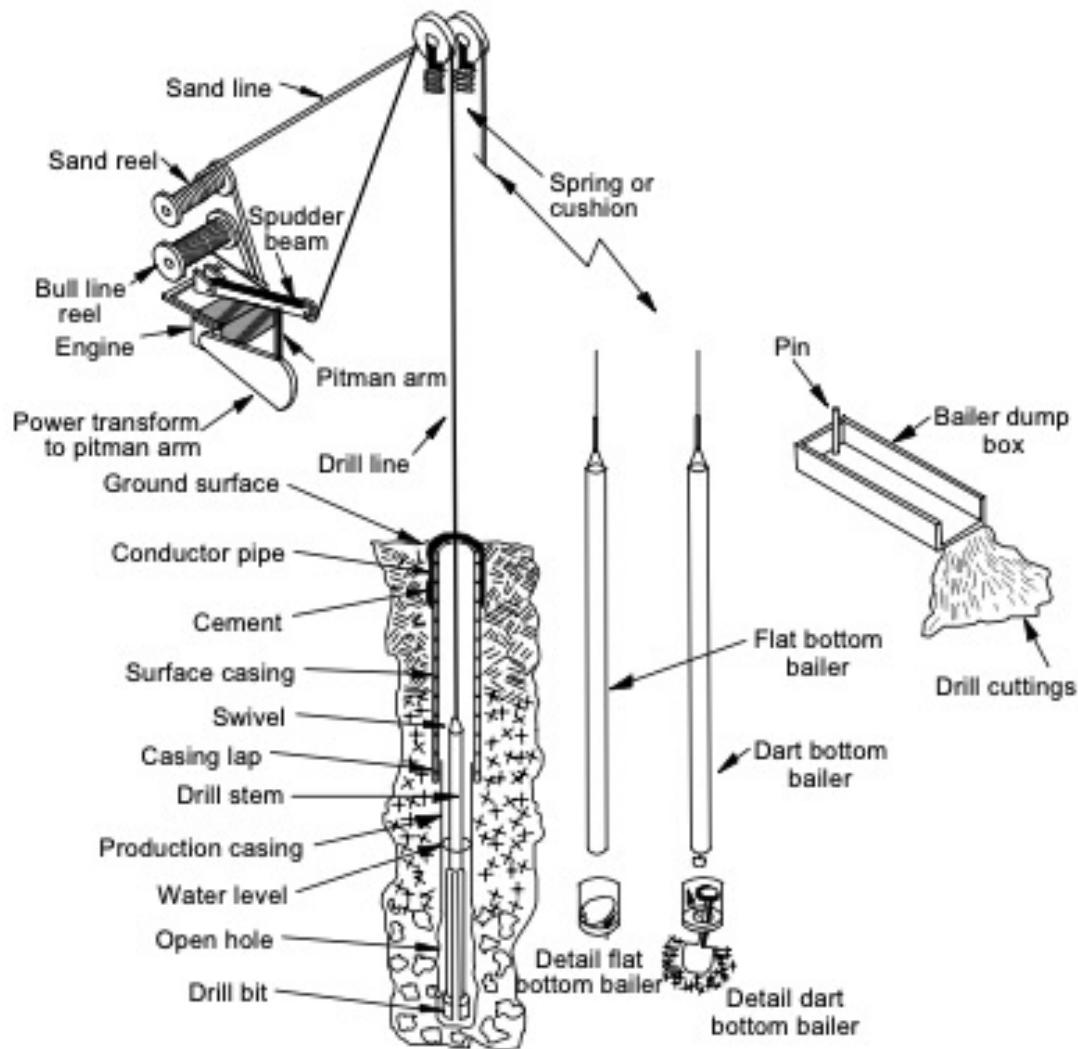
- ✓ Theories and debates about formation of hydrocarbon in the mother earth are not uncommon i.e. whether its organic/inorganic.
- ✓ Majority of the world believes that the Hydrocarbon has organic origin and was formed due to burial of organisms thousands of years ago, and were subjected to temperature and pressure conditions after burial.
- ✓ Typical Hydrocarbon Formation as taught in most universities looks like the figure shown.
- ✓ After forming in the source rock Oil and Gas migrates owing to density difference over water and gets trapped.
- ✓ Earth Science students like Geologist and Geophysicist often referred as G&G, review geology, timescale, and perform studies to determine when, where and what to drill.
- ✓ They primarily look for the structural traps where the oil and gas can accumulate.

...When, What and Where To Drill



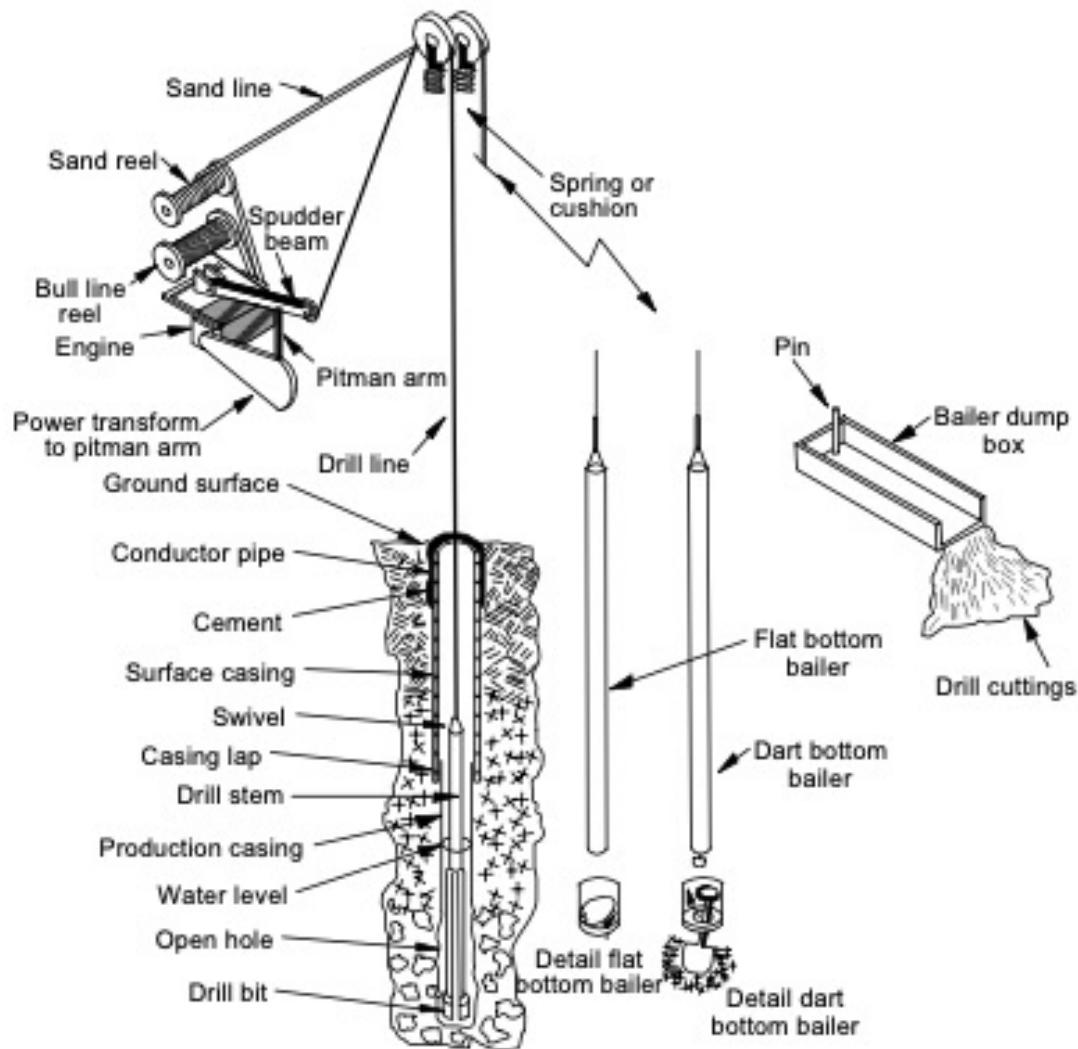
- ✓ G&G folks also review the events over the Geological time scale / in current history and look for the signs of earth crust movement , analyse the causes such as change in thrust / strike / slip and determine the location to drill.
- ✓ Several causes for traps are studied along with seismic surveys. Seismic surveys are done to collect the data about sound wave velocities through the rock matrix. The travel time needed for compressional and shear wave is noted and processed using advance computations.
- ✓ Seismic data processing and interpretation can help to create data rooms for review of the reservoir model to drill.
- ✓ Several computer simulations are available to answer the W Questions.
- ✓ Let's also Review "How and with What to Drill i.e. Processes / techniques and Equipment to drill

Drilling Techniques / Processes (Cable tool)



- ✓ Drilling can be done via Percussion / rotation and the equipment required change based on the drilling technique used.
- ✓ Cable tool / percussion drilling is a process of hoisting a heavy tool striking down on the ground similar to the construction sites.
- ✓ This process uses basic equipment and typically used for shallower drilling
- ✓ Few advantages are cost effective equipment simple to maintain, and less chances for formation damage.
- ✓ Major disadvantage is the process is slow as it involves recovery of drilled material using a bailor.
- ✓ Not used in modern times as Rotary drilling is more effective

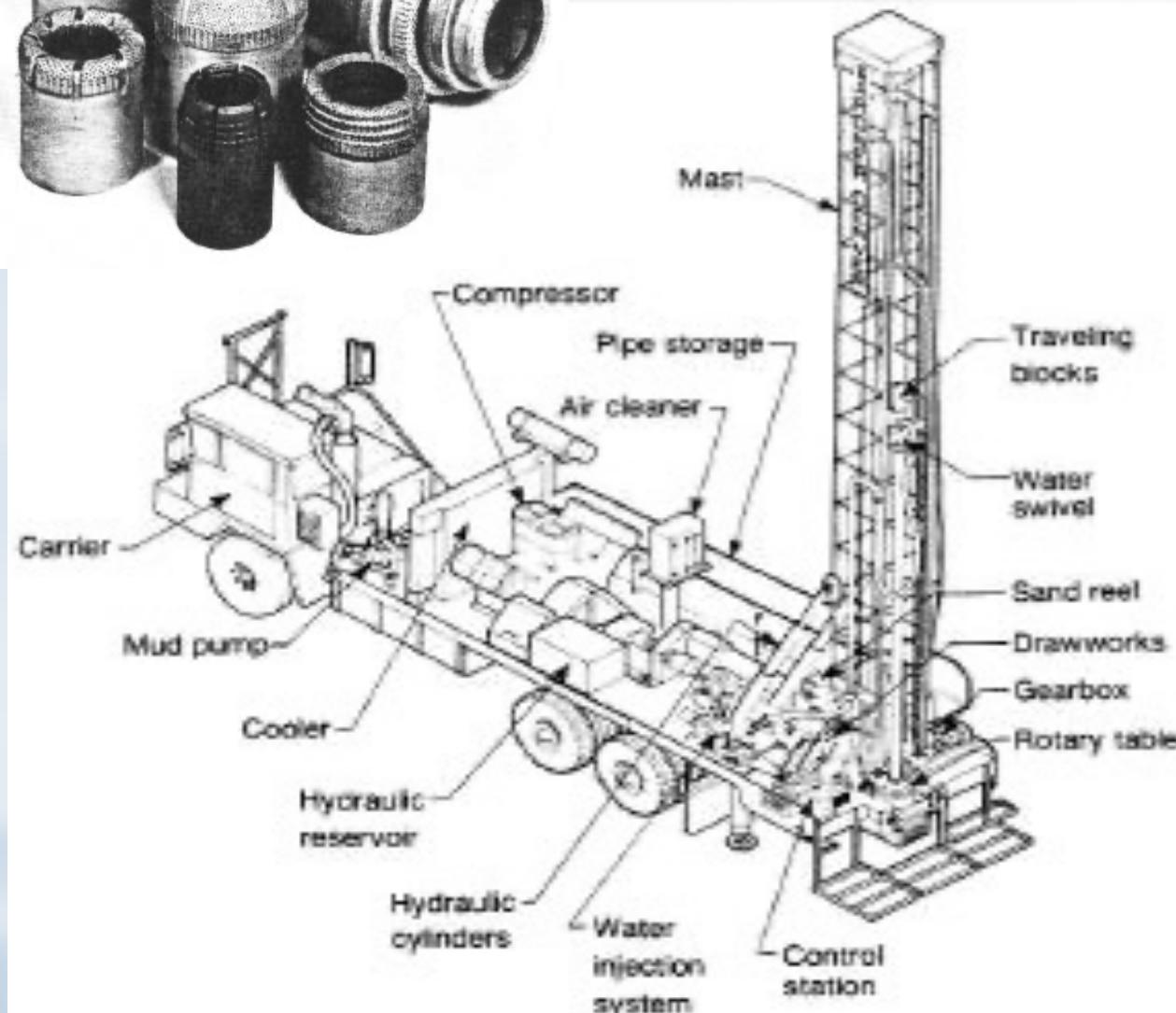
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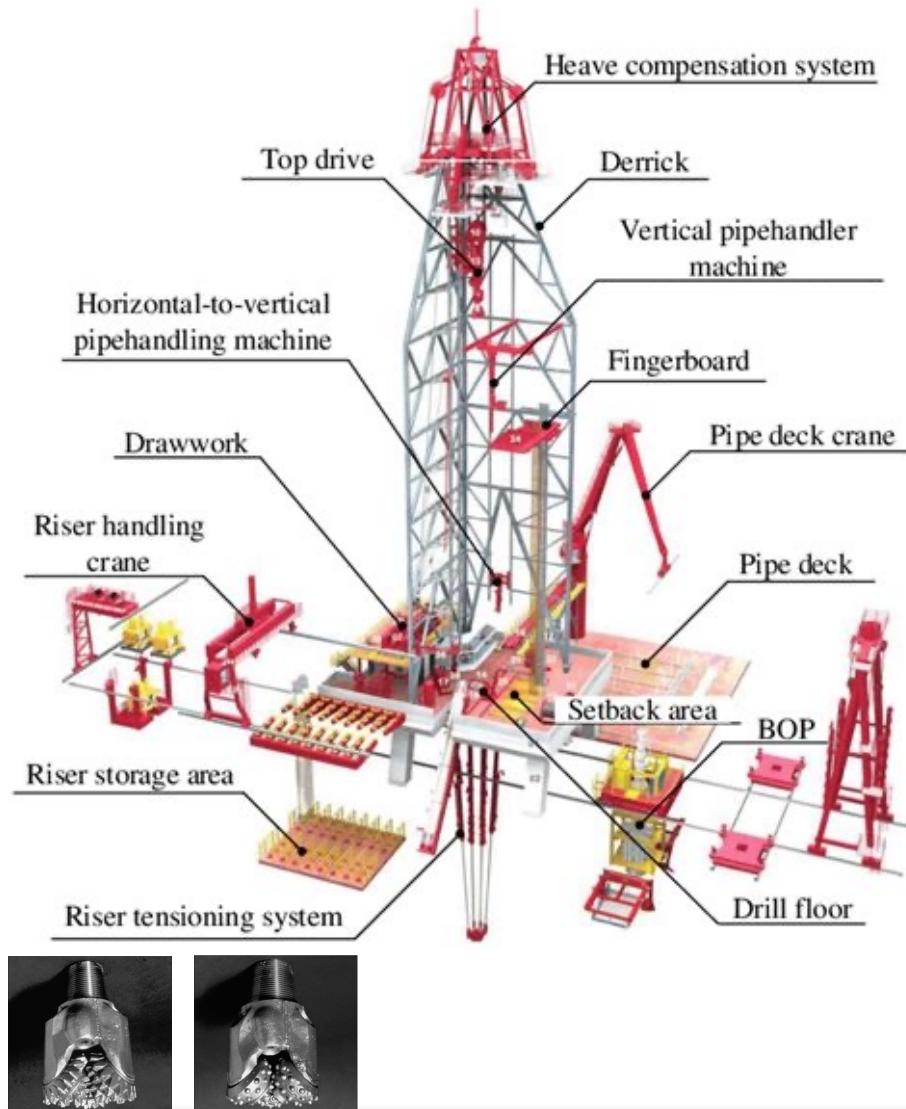
ng Techniques / Processes (Coring)



- ✓ Coring is another technique where a cores of sections of the earth / formation are required.
- ✓ The equipment will be similar to the Rotary drilling
- ✓ A typical land coring rig rig is shown in attached pictures.
- ✓ Typical advantage can be cost effective equipment set up aimed at offline work and less chances for formation damage.
- ✓ As the equipment is similar to the Rotary rig, the equipment can be further optimized for recover the core from the sections desired using core barrels and bits shown below.



Drilling Techniques / Processes (Rotary)



- ✓ Rotary drilling is most effective method and used very widely.
- ✓ Basic equipment have evolved over the years and the optimization is ongoing.
- ✓ The Rotary drilling equipment shall have draw works to spool drilling line on a hook to pull and push the drill pipe and the BHA in the well. This is hoisted within a Mast which supports the reciprocation and handling of pipe and the Bottom Hole Assembly (BHA) required to drill hole.
- ✓ The pipe conveys the fluids and BHA is typically made up of drilling bit with nozzles, which rotate and remove formation sections to make a hole / drill. The removed material from formation is brought to the surface with help of a fluid called drilling mud, which is pumped inside the drill pipe.
- ✓ Drilling operations are controlled from Rig floor supported by substructure / racking system, pumps, Crane and storage equipment. Additional equipment such as Heave compensators are required for offshore operations

Why Drill (+ W ?) Summary

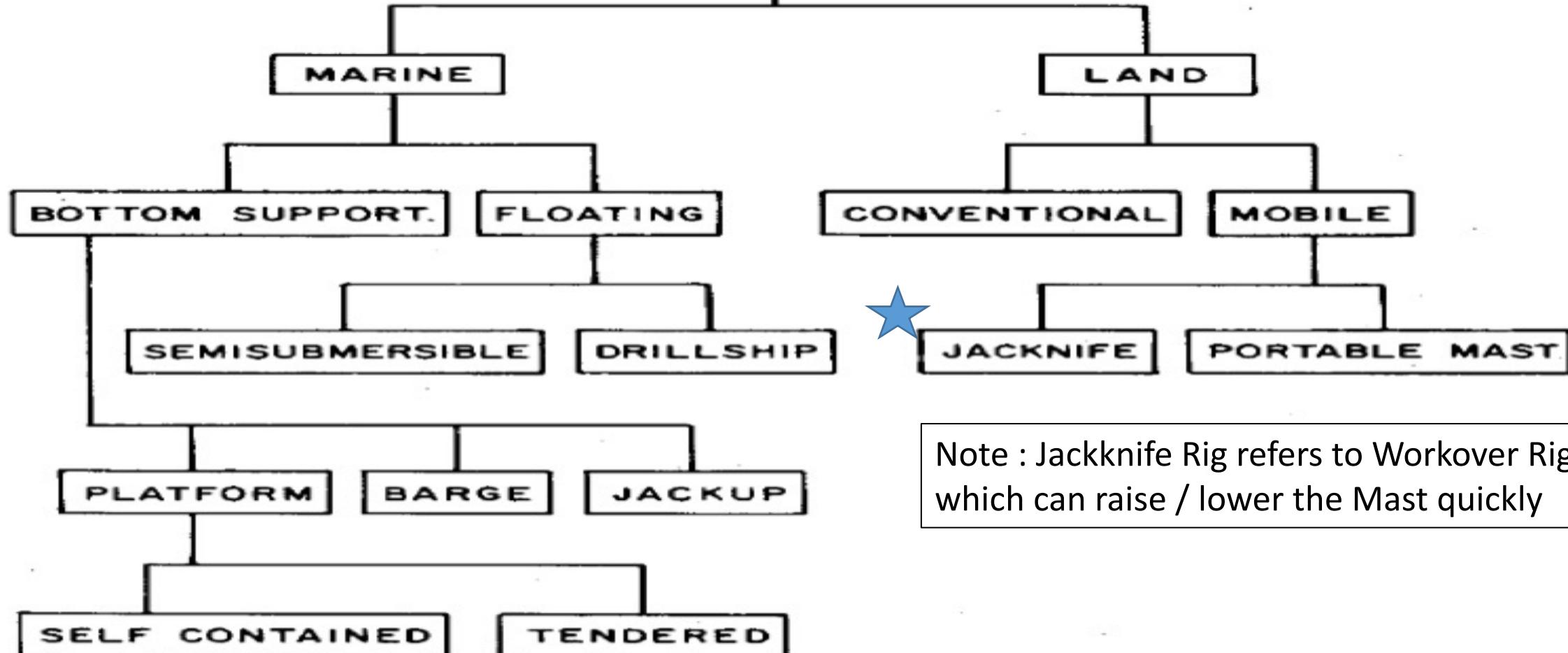
- ✓ Drilling is required for any/all of following (And More....???) :
 - ✓ To collect data related to the formation
 - ✓ To establish presence of hydrocarbon in the formation
 - ✓ To provide sustainable access to the formation support the well construction
 - ✓ To establish conduit for producing for well fluids from a well
- ✓ Besides Why, there are more W questions about drilling
 - ✓ The G&G folk help to answers when where and what to drill.
 - ✓ How to Drill caries in techniques processes
- ✓ Locations can be simple or Complex, we have the solutions !!

Equipment to Drill / Types of Rigs

- ✓ Historically the drilling process has evolved from reciprocating type drilling to the rotary drilling. Most of the rigs operating today barring a few experimental set ups are classifications of Rotary drilling rigs.
- ✓ Let's see the different types of Rig classification available and discuss each type of rig and its application

Equipment To Drill (Type of Rigs)

Rotary Drilling Rig Types



Type of Rigs – Marine Rigs

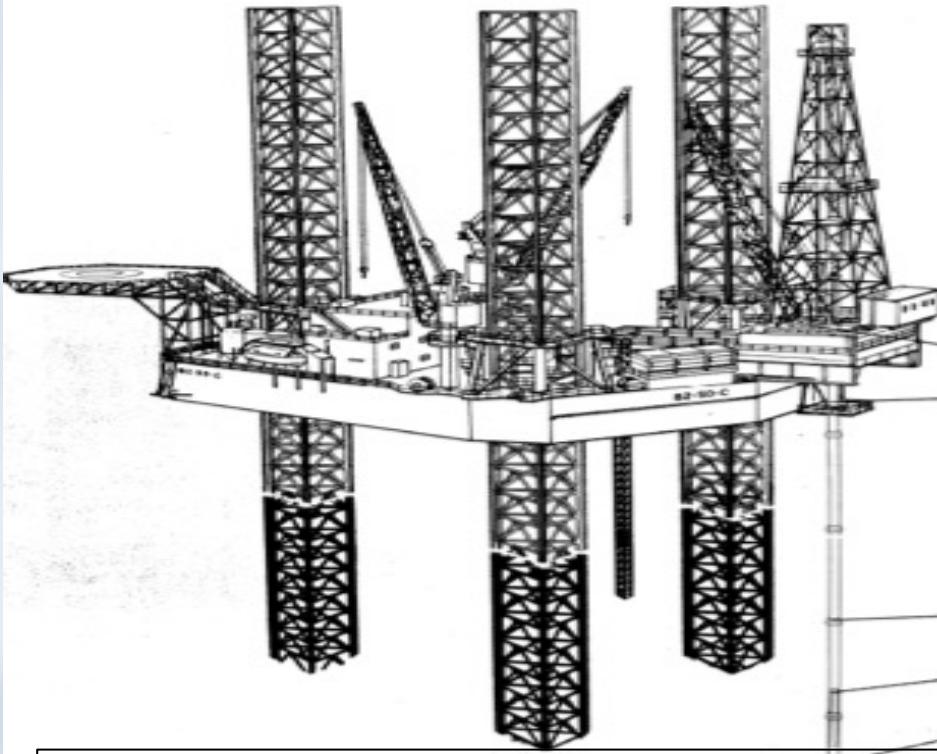


- Marine Rigs are for applications in the Sea / Lake. These can be bifurcated in Floating Vs Bottom Supported.
- Floating rigs can further be classified as Fixed or Free floating (and self propelled) such as Drill ships.

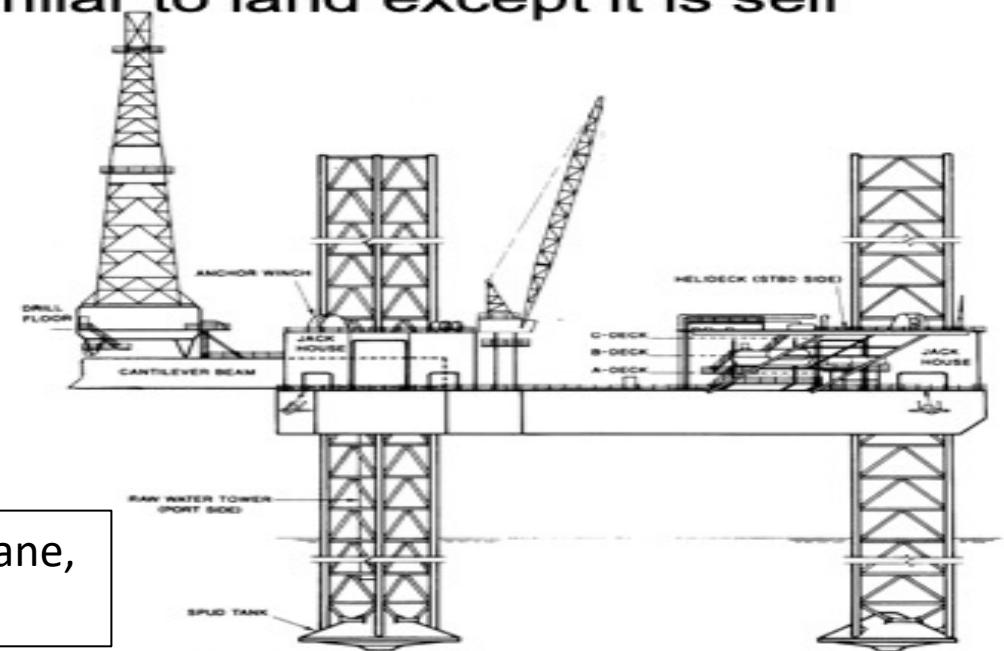
- Self Supported Rigs are either Jack up or Barge / Pontoon type of rigs.
- Water depth is critical in choosing the rig
- The forces of waves, wind, and tides / currents of water have impact on selecting the rig.
- There are also locations where the tidal waters recede and the rig is exposed to marshy land. Structural design is very challenging
- **Let's discuss each of these rigs**

Bottom Supported Rigs

Jackup rigs



- Used for both wildcat and development drilling
- Shallow water up to 350-500ft water depth
- Derrick may be fixed or cantilevered.
- Operation similar to land except it is self contained.

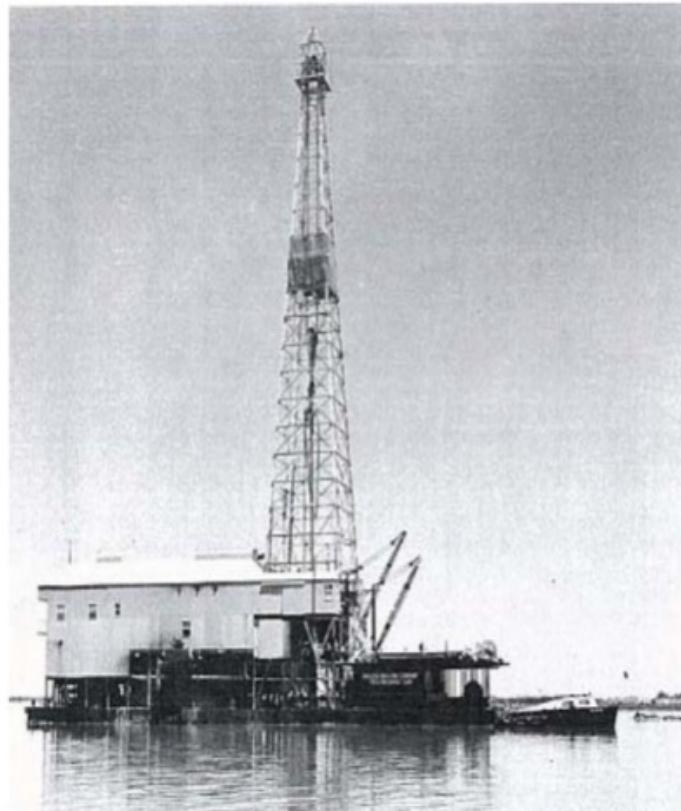


Self Contained refers to the rig complete with allied Services such as crane, cement, drilling fluids, Access (Helicopter) vessel support etc.

Platform Supported / Tendered Rig

Inland barge

- Used in swamps, bays, inland water, shallow offshore.
- Floated and towed to location
- On location these rigs are submerged
- Well is drilled
- Personnel and supplies are brought in by boat.



- Typically such barge assist rigs are deployed in calm weather conditions.
- Operating Weather / Sustainability of such type of rigs for harsh sea / large water depths / environment is very limited.

Platform Supported / Tendered Rig



- ✓ Platform supported Rigs are typically used for oilfield locations where necessary infrastructure is available for production.
- ✓ Typically the drilling equipment and systems are mounted on well platforms which are connected to production facilities
- ✓ In India ONGC has used such types of rigs extensively which were mounted on Normally Unmanned Platform similar to the one shown in the adjacent picture.
- ✓ Drilling equipment are mobilized to suit the operational requirement. These equipment are mobilized for specific purpose such as infill / development drilling / slot recovery
- ✓ Independent platform support rigs which are designed considering location specific requirements can also be tailor made.
- ✓ These rigs help in optimizing the drilling costs for the project

Drillship



- ✓ Drillships are primarily used for water depths in excess of 500 meters.
- ✓ Often exploratory drilling is done using drill ships for deepwater environment.
- ✓ Drillships are normally self propelled, and can easily be transported from one location to the next with help from supply boats
- ✓ Typically drill ships are self contained with the services required for drilling.
- ✓ Special equipment such as Heave compensators are required to be deployed considering the surface forces of wind, waves, and currents in the deep sea.
- ✓ Modern day drillships are also designed with double derrick to facilitate drilling at a faster rate.

Semi Submersible Rig



- ✓ Semi Submersible rigs are primarily used for water depths in excess of 500 meters.
- ✓ Semisubmersible rigs provide excellent facility to accommodate early production systems (EPS) besides drilling and in general have large capacity / volumes for ballasting operations
- ✓ Semisubmersible rigs provide adequate space and generally has better weather stability than the drillship.
- ✓ Typically development drilling is done using Semisubmersible rig, to take benefit of the storage volume
- ✓ Special equipment are still recommended, such as Heave compensators are required to be deployed considering the surface forces of wind, waves, and currents in the deep sea.
- ✓ Modern day rigs are also designed to suit specific requirements such as EPS

Summary of Marine Rig Deployment

Drillship

Operates at water depths up to 12,000ft.



Semi-submersible

Operates at water depths up to 10,000ft.



Jack-Up Rig

Operates at water depths up to 500ft.

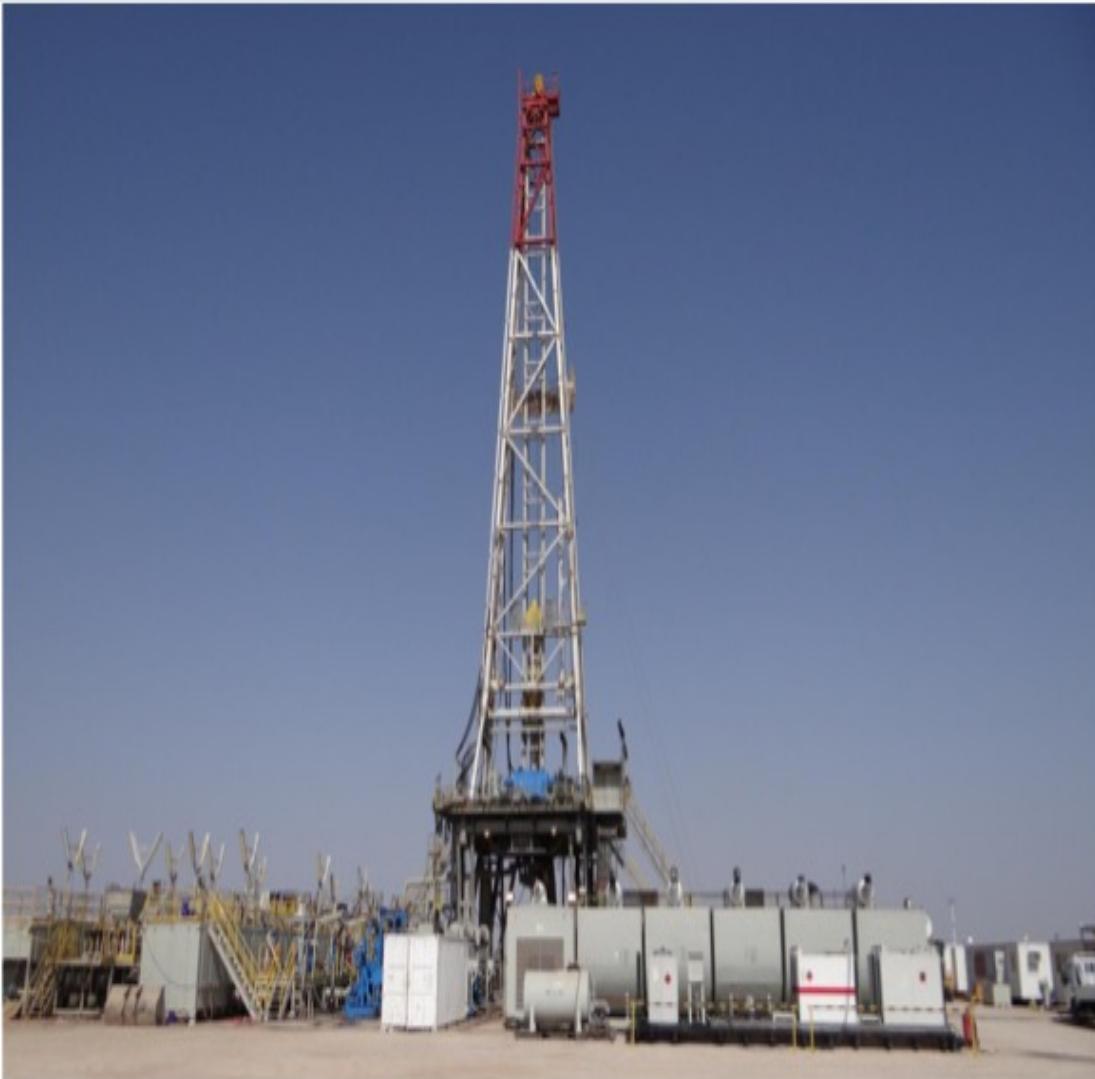


Drilling Barge

Operates in shallow waters.



Conventional Land Rig



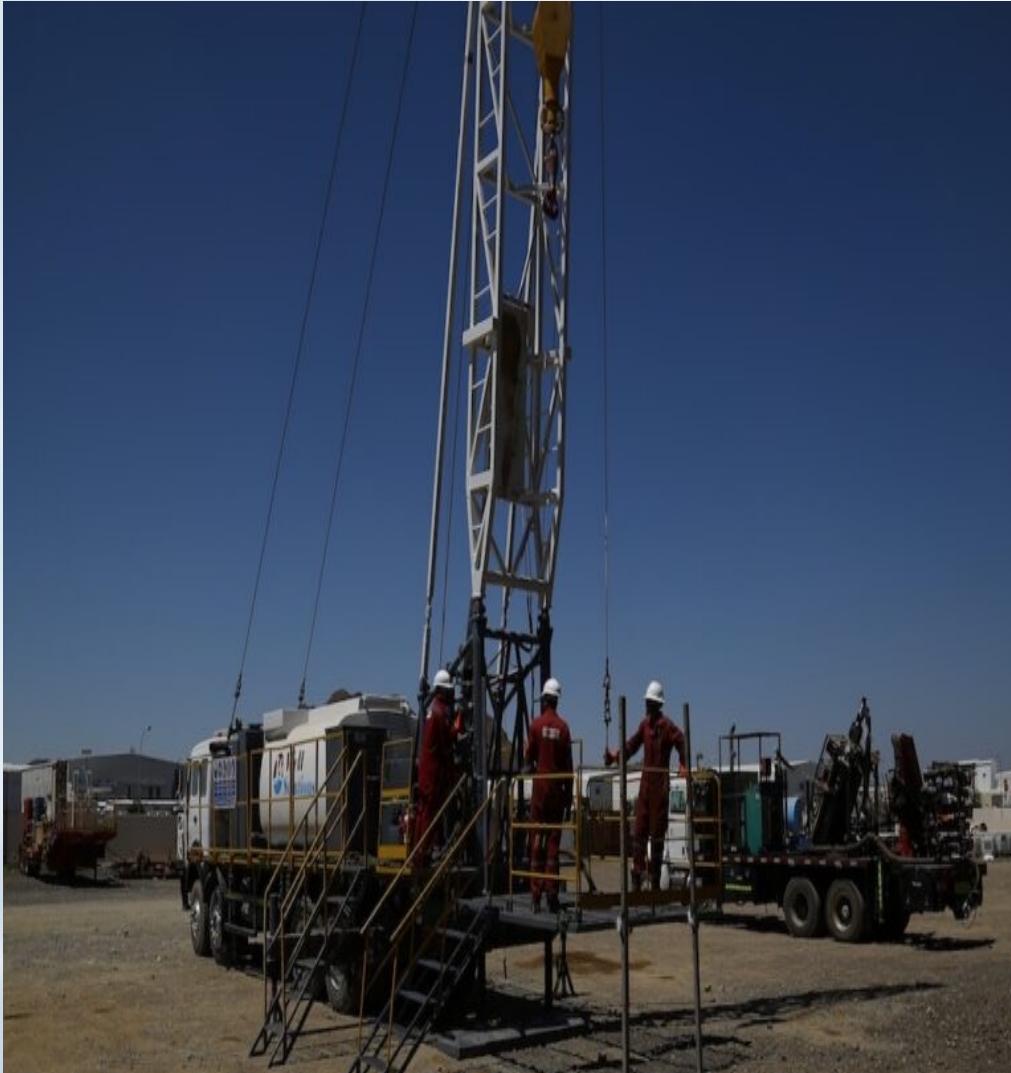
- ✓ Conventional Land rig design is made considering the roads available for transport. That is the surface transport may require the rig to be dismantled to suit the transport conditions.
- ✓ Rigging up and Rigging down along with inter location move can take several days based on the transport facilities and road / weather conditions.
- ✓ All the Services such as Cementing, Drilling fluids and well testing / logging can be mobilized as per the requirement.
- ✓ Major equipment such as Draw works, Mast, Substructure are designed to suit drilling depth requirement such as 10000ft / more Less than 5000 ft.
- ✓ The drilling depth is a key parameter to select a land rig of a particular size. Either on Horse power / hoisting capacity.
- ✓ Modern day Land rigs also support internet facility real time data transfer to base.

Conventional Land Rig - Components



- ✓ Conventional Land rig shall have following components
 - ✓ Mast to accommodate the drill pipe in stands
 - ✓ Casing stabbing Board / Casing handling equipment
 - ✓ Rotary Table + V Door to assist drilling
 - ✓ Kelly bushing , drilling hook / top drive
 - ✓ Driller's console and equipment such as Slips tongs to handle drill pipe / drill string
 - ✓ Substructure to support the Rig Floor and Pressure Control Equipment (BOP)
 - ✓ Mud Pumps and Tankages to Prepare and Pump Mud
 - ✓ Cementing unit along with Camp Accommodation for drilling crew.

Truck Mounted Land Rig



- ✓ Truck Mounted (Self propelled) rigs are deployed for the purpose of workover drilling, and can be mobilized swiftly.
- ✓ These rigs have a smaller footprint as compared to conventional drilling rig and are often having lesser capacity to hoist the drill pipe.
- ✓ The rigs are very light and can be "fit for purpose" by adding / removing the additional components like power swivel, power tongs, truck mounted cement unit
- ✓ Typically workover drilling involves pulling of production tubing from an existing well and servicing the section of the well such as remedy of casing, setting a bridge plug to isolate a particular section
- ✓ Window milling / extended reach drilling can be performed using such rigs in addition to equipment package mobilized in conjunction with these rigs such as Coil Tubing



Rig 22
420 kip Hydraulic Workover Unit



- ✓ Sometimes Hydraulic workover Unit are also called Rig.
- ✓ Essentially the equipment is similar to the rigs.
- ✓ The only difference is the equipment works with hydraulic rather than the diesel engines / SCADA supplying the power to the draw works. And hoisting the pipe..

<https://youtu.be/ZR3GyaWmnis>

Homework !!

Watch the 15 minute Video about life on the Rig

This is a video of Weatherford Rig .. Please watch carefully and ask questions !!

https://youtu.be/O17uiSIK_go



Thank You

Thank You for your undivided attention !
We are now open to questions.

