"Capacity Building and Strengthening Institutional Arrangement"

Workshop: Quantitative risk assessment of oil and gas plants"

Drilling Technologies Aspects

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APAT

Agency for Environmental Protection and Technical Services

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1. Introduction

Drilling may be classified as the science of making, maintaining and abandoning a hole in the ground.

Wells may be as short as a few hundred meters to well over till 10000 meters.

In order to drill the hole there are two essentials things to do:

1. A drilling rig to supply power and hoisting capabilities
2. A drilling fluid to control subsurface pressures, remove the drilled material from the hole, lubricate the drill bit and, in same cases, power down hole motors or turbines

1. Introduction

The hole is not a single hole but a series of progressively smaller holes drilled sequentially.

The number of sections required in any well is determined by the geology and the fluid pressures within permeable formations.

Regarding geological aspects, oil and gas could be accumulated if the following conditions are satisfied:

a) The presence of reservoir rock, such as formations containing interconnected pores (unconsolidated sands) or crack and voids (some limestones)
b) The presence, at the top of reservoir rock, of a formation (anhydrite or shale) impervious to the passage of fluids
c) The presence of "closure", that prevents the lateral escape of fluids.

1. Introduction

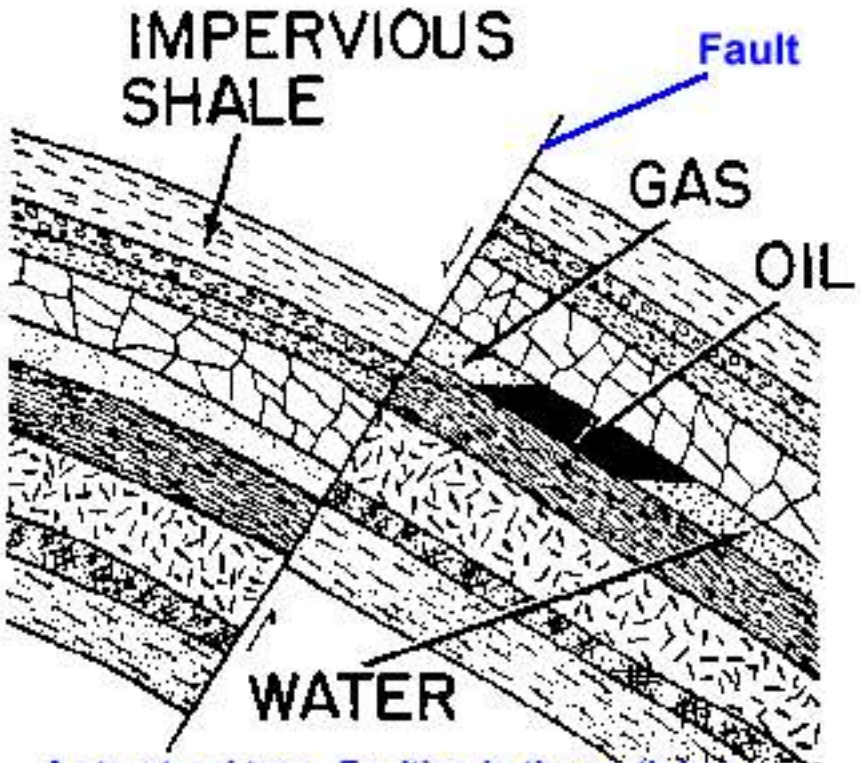
These conditions define a potential oil trap in which oil, gas and water, migrating from the source rock may be accumulated.

The traps have been classified by petroleum geologists into two types: structural and stratigraphic

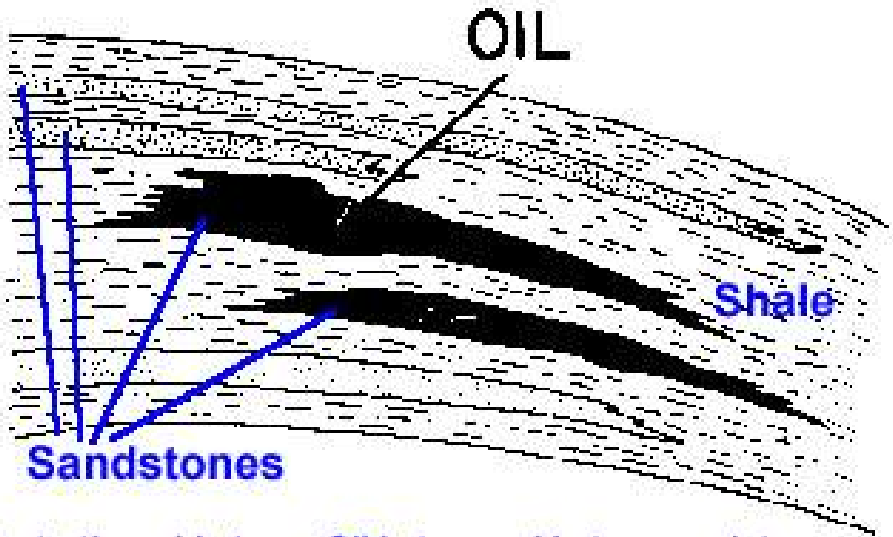
Structural traps are formed by a deformation in the rock layer that contains the hydrocarbons (e.g., fault traps and anticlinal traps).

Stratigraphic traps are formed when other beds seal a reservoir bed or when the permeability changes within the reservoir bed itself.

1. Introduction



A structural trap. Faulting in the earth has caused vertical movement of the rock layers. Gas and oil cannot pass through the fault boundary, and they are trapped.



A stratigraphic trap. Oil is trapped in two sandstones which are surrounded by shale. The shale prevents the oil from escaping.

2. Exploration methods

Exploration methods are the techniques employed in the search for oil and gas, and the main are:

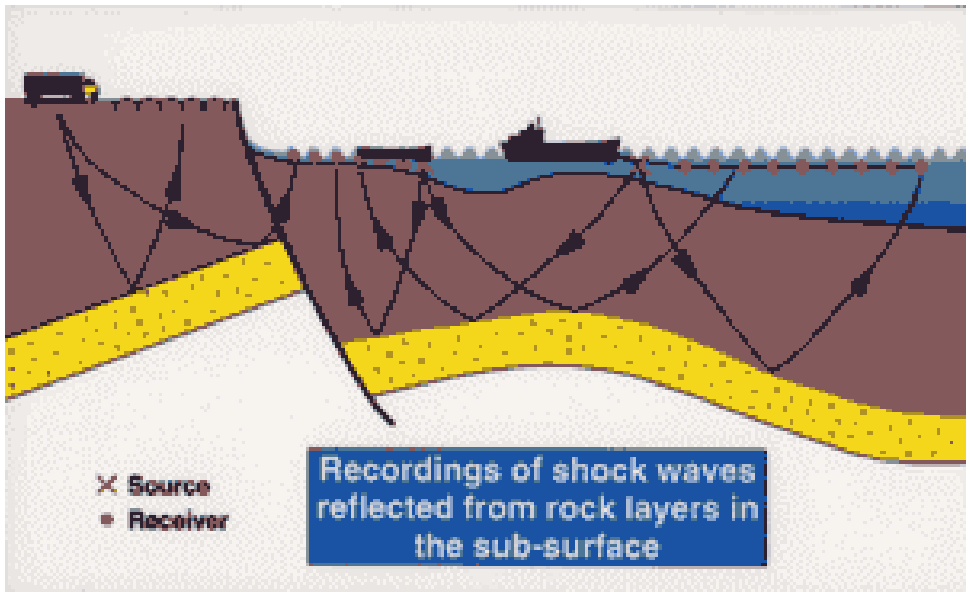
Aerial surveying: before starting the exploration of new territory it is suggested to photograph the whole from the air by airplane. Studying these photographs is possible to draw a map to show the geological surface features.

Geological exploration: the outcrops of the rock layers in the potential oil bearing area are mapped as accurately as possible a result of geological observation on the ground. The physical characteristics and the fossil contents of the rocks are recorded, and samples taken to correlate with beds exposed elsewhere.

2. Exploration methods

Geophysical exploration: geophysical surveys are made in areas already explored geologically in order to obtain corroborative subsurface evidence. They are mostly applied where there is no surface evidence of structure, as in desert, river delta, water covered areas. The main method are seismic, gravimetric, magnetic and electrical.

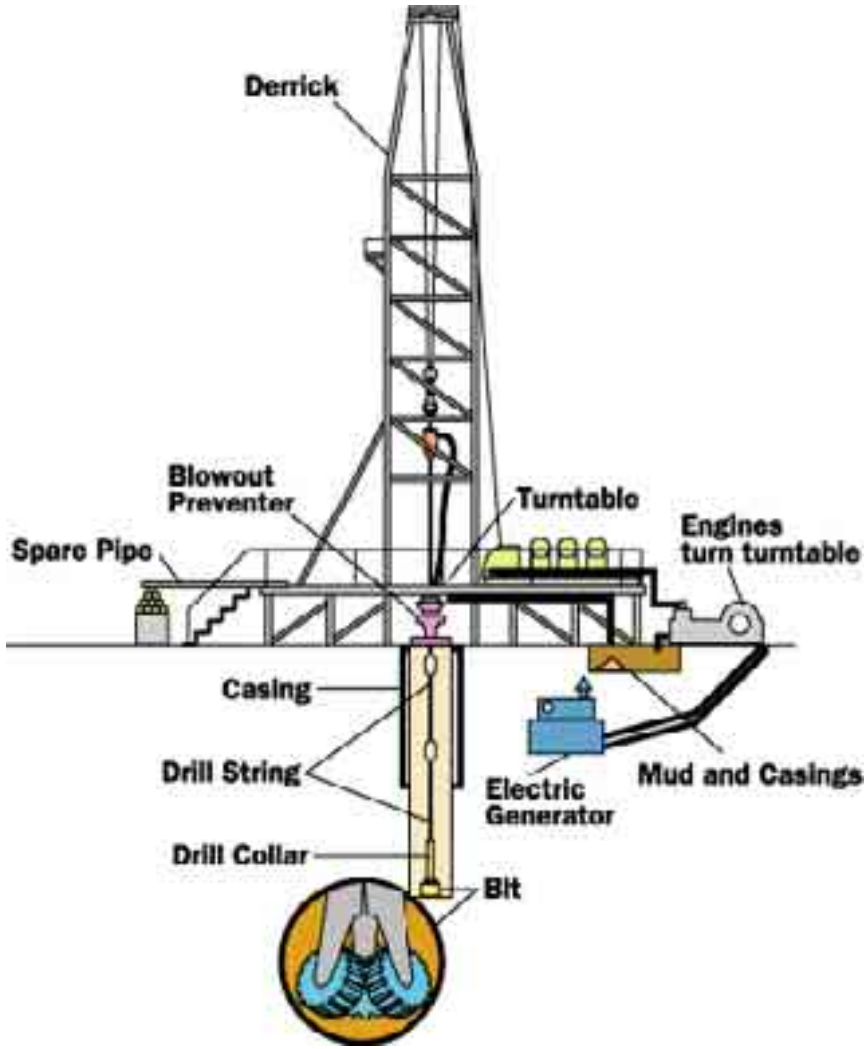
The seismic method



3. Drilling techniques

The current method of drilling is known as the “rotary method”.

A rotary drilling rig contains all necessary equipment to circulate the drilling fluid, hoist and turn the pipe, control down hole pressures, remove cuttings from the drilling fluid, and generate onsite power for these operations.



3. Drilling techniques

Bit and drilling string: the spearhead of the drilling rig is the bit, which cuts its way far beneath the surface through formations. The bit is screwed to the bottom of the drilling string, made up of lengths of special steel pipe (drill pipe)

3. Drilling techniques

To drill the well

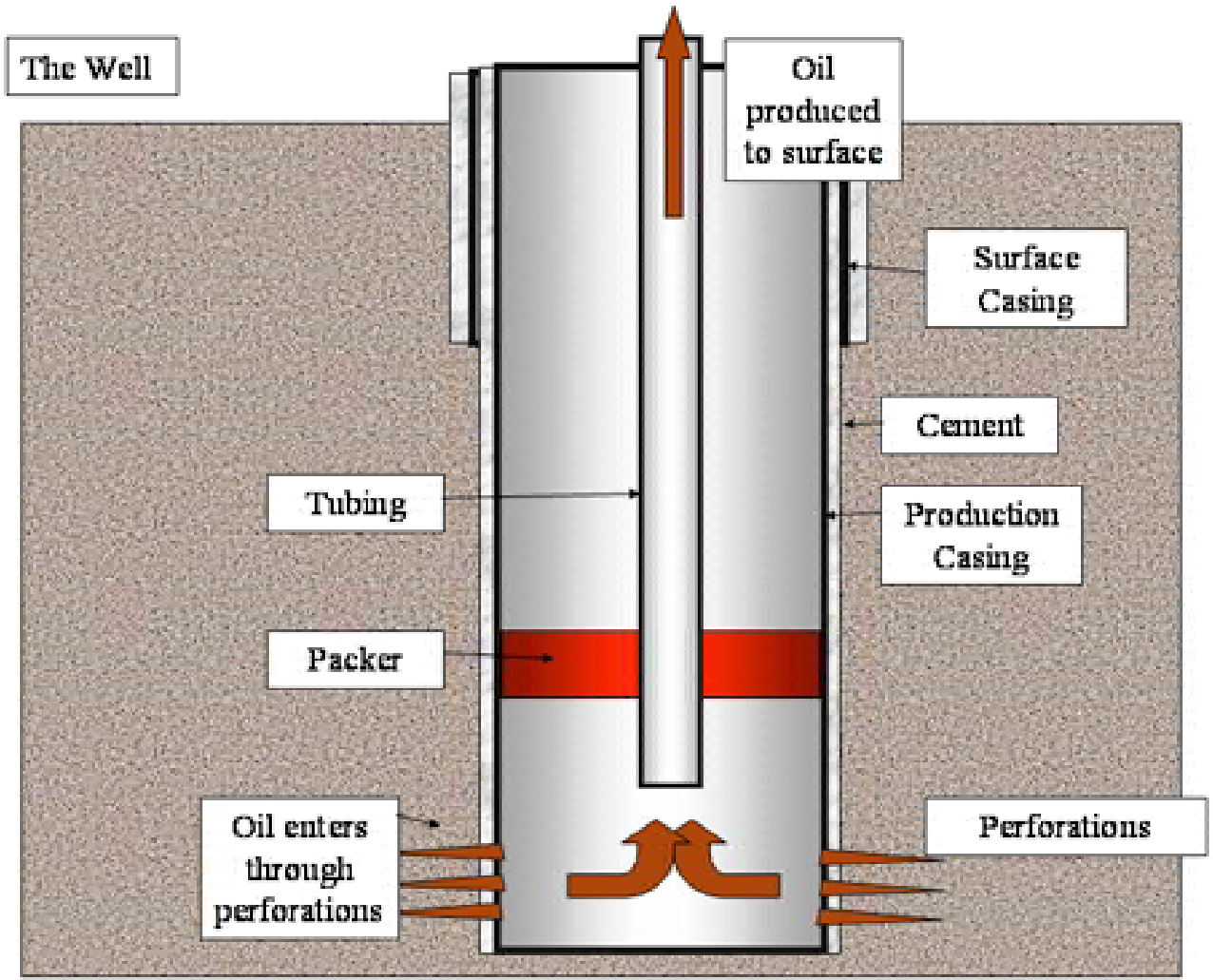
•The drill bit, aided by rotary torque and the compressive weight of drill collars above it, breaks up the earth.

•Drilling fluid is pumped down the inside of the drill pipe and exits at the drill bit and aids to break up the rock, as well as clean, cool and lubricate the bit.

•The generated rock "cuttings" are swept up by the drilling fluid as it circulates back to surface outside the drill pipe.

•The pipe or drill string, to which the bit is attached, is gradually lengthened as the well gets deeper by screwing in several 10 m joints of pipe at surface.

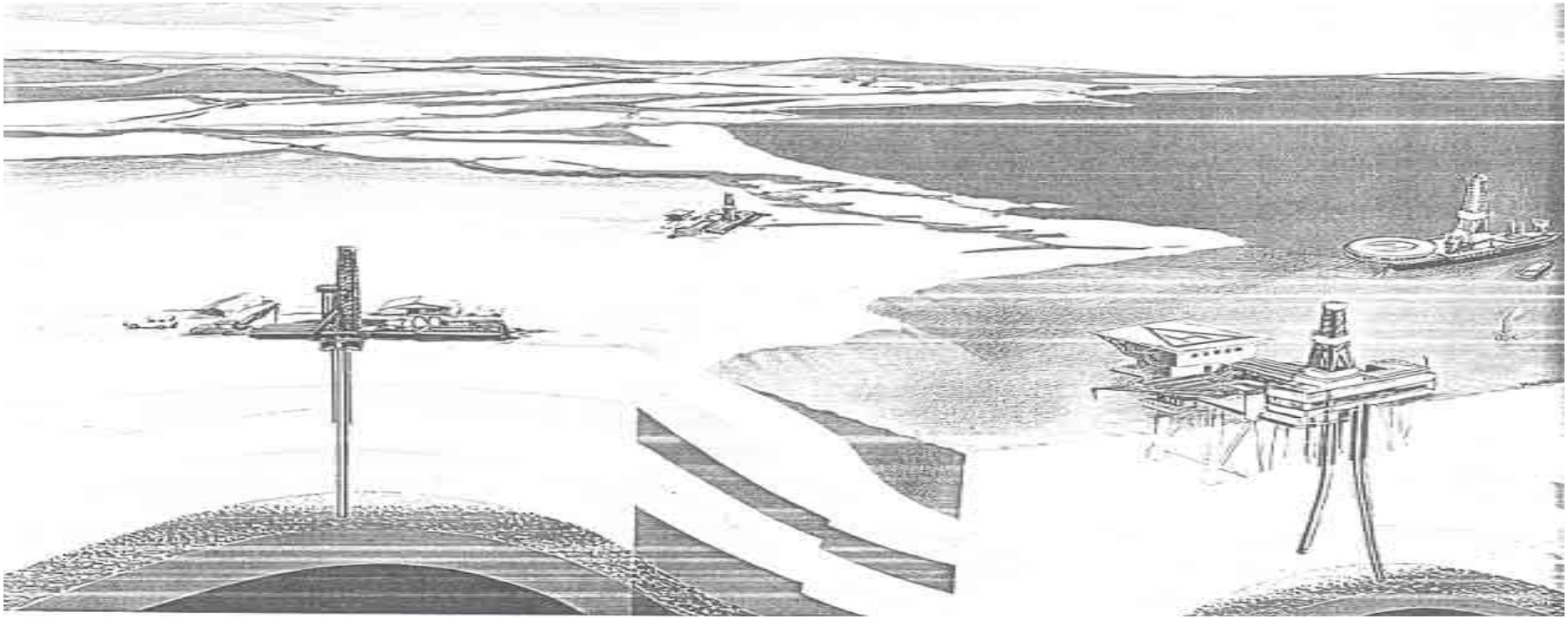
3. Drilling techniques



4. Drilling technologies

Geophysical and geological surveys are useful because can suggest the underground conditions that may be favourable to oil accumulation but only the drill process can prove the oil presence.

The drilling of explorative wells is the last part of the process to find oil or gas deposits, that can be performed at ground or at sea.



4. Drilling technologies

4. Drilling technologies

5. Drilling fluids

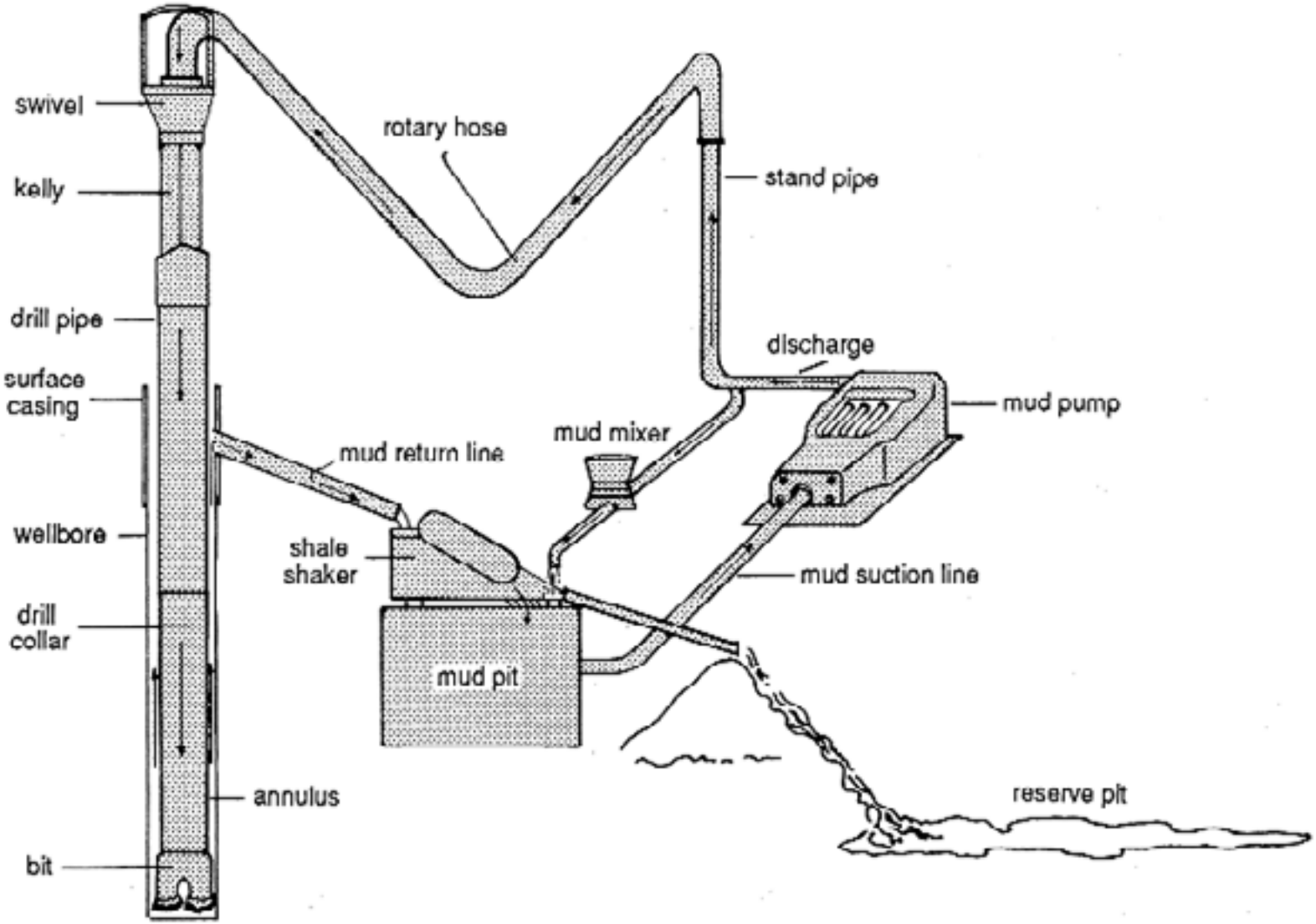
Drilling fluids (muds): Drilling mud, also called drilling fluid, is a lubricant used while drilling oil and natural gas wells and in exploration drilling rigs.

The progress and efficiency of drilling depend largely on the use of the right drilling fluid for the rock being drilled.

The mud is pumps through the drill string where it is sprays on the drill bit (cleaning the bit in the process), the mud then travels back up the annular space between the drill string and the sides of the hole being drilled up through the “surface casing” and emerges at the surface.

Cuttings are then filtered out and the mud is then pumped back down and is continuously recirculated.

5. Drilling fluids



5. Drilling fluids

The purposes of drilling mud or drilling fluids are to:

1. Remove cuttings from the formation produced by the bit at the bottom of the hole and carry them to the surface.
2. Lubricate and cool the drill bit during operation as friction causes high temperatures down-hole that can limit tool life and performance.
3. Maintain hydrostatic equilibrium. Are used high-density additives (barite, hematite) which create hydrostatic pressure that prevents water entering the well or hold the oil/gas inside, prevent a blow out and to physically stabilize the formation.
4. Build a filter cake on the hole wall, preventing fluid loss.
5. Support and prevent caving of the wall of the hole.

5. Drilling fluids

Classification of drilling fluids based on their composition:

- water-base
- non-aqueous or oil/synthetic base (oil, olefin, or other synthetic fluid)
- gaseous or pneumatic

From 2002 there is the new environmental regulations on Synthetic Mud.
New regulations restrict the amount of synthetic oil that can be discharged as a percentage by weight of synthetic fluid on cuttings that have been drilled and are being discharged overboard.

6. Environmental drilling hazards

Blowouts are potentially the most dangerous and disastrous hazard, because of the risk of fire.

A blowout is the uncontrolled release of a formation fluid, usually gas, from a well being drilled, typically for petroleum production.

A blowout is caused when a combination of well control systems fail (primarily drilling mud hydrostatics and blowout preventers) and formation pore pressure is greater than the well bore pressure at depth.

Blowouts are dangerous since they can eject the drill string out of the well, and the force of the escaping fluid can be strong enough to damage the drilling rig. Blowouts usually ignite.

6. Environmental drilling hazards

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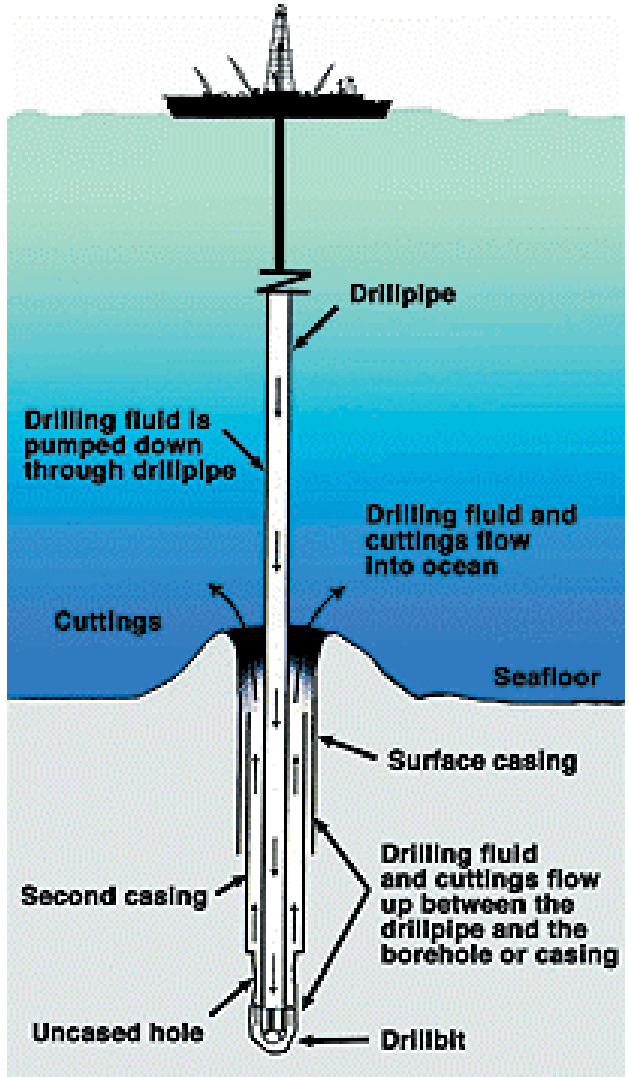
7. Marine drilling

The marine drilling techniques are the same of drilling techniques on the ground; the only difference consist in the supporting structures of the rigs.

There are four main types of platforms and rigs:

- Fixed Platforms
- Jack-up Platforms
- Semi-submersible Platforms
- Drillships

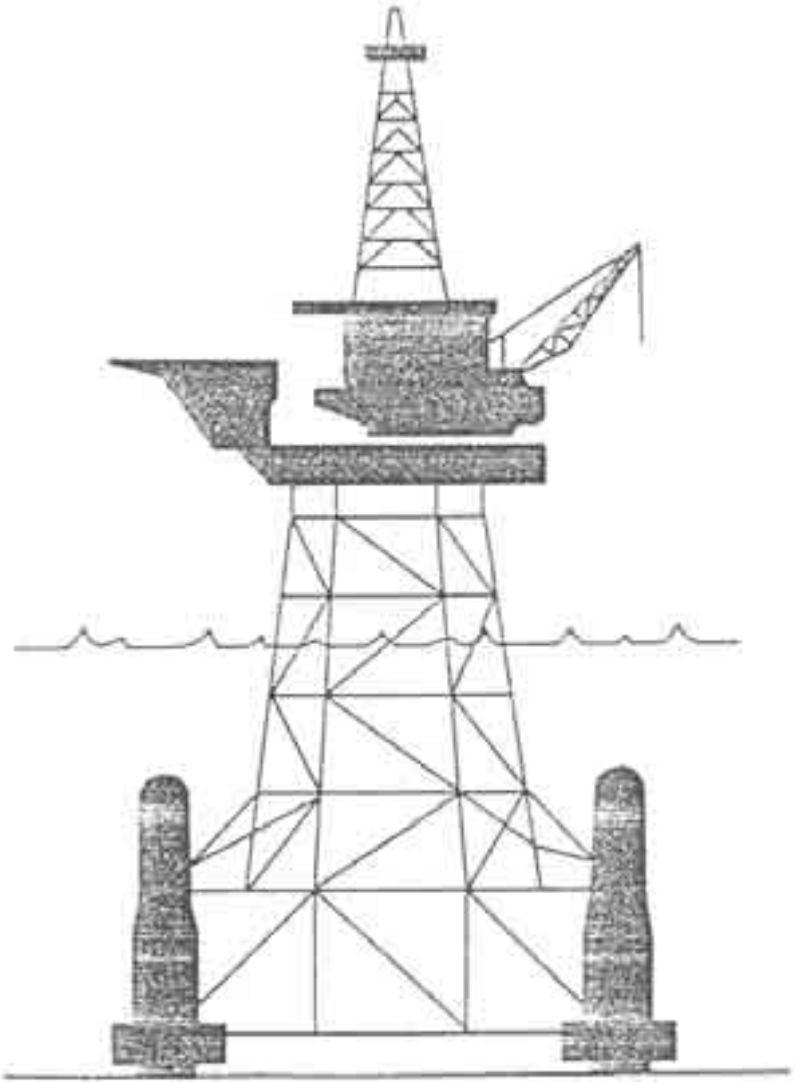


7. Marine drilling

Fixed Platforms: these are built on concrete and/or steel legs anchored directly onto the seabed, supporting a deck with space for drilling rigs, production facilities and crew quarters.

Various types of structure are used, steel jacket, concrete caisson, floating steel and even floating concrete.

Fixed Platforms can be used in depths up to about 520 m.

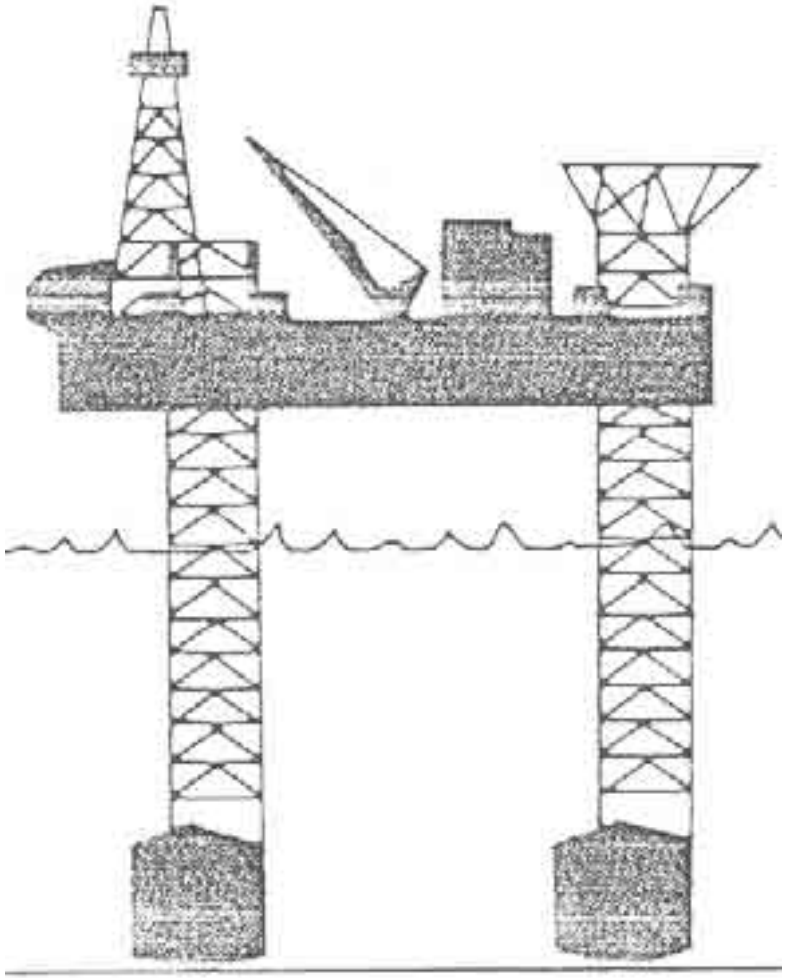


7. Marine drilling

Jack-up Platforms, as the name suggests, are platforms that can be jacked up above the sea, by dint of legs than can be lowered like jacks.

These platforms, used in relatively low depths, are designed to move from place to place, and then anchor themselves by deploying the jack-like legs.

Jack-up_Platforms can be used in depths up to about 100 m.

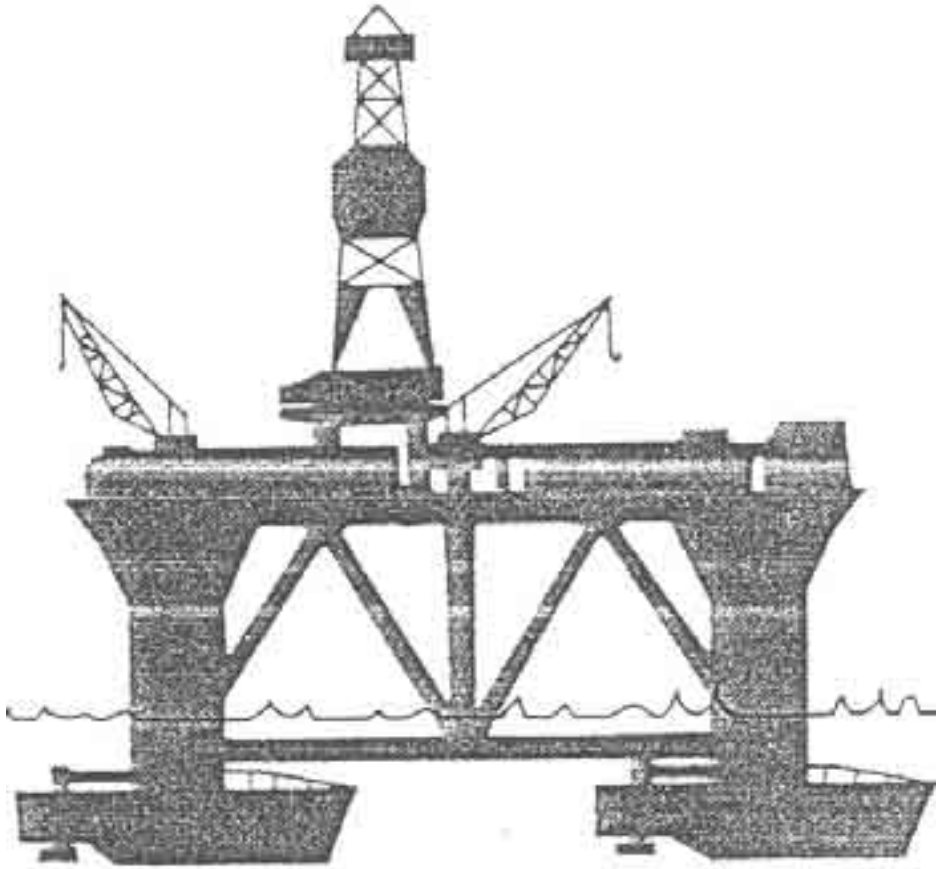


7. Marine drilling

Semi-submersible Platforms having legs of sufficient buoyancy to cause the structure to float, but of weight sufficient to keep the structure upright.

Semi-submersible rigs can be moved from place to place; and can ballasted up or down by altering the amount of flooding in buoyancy tanks.

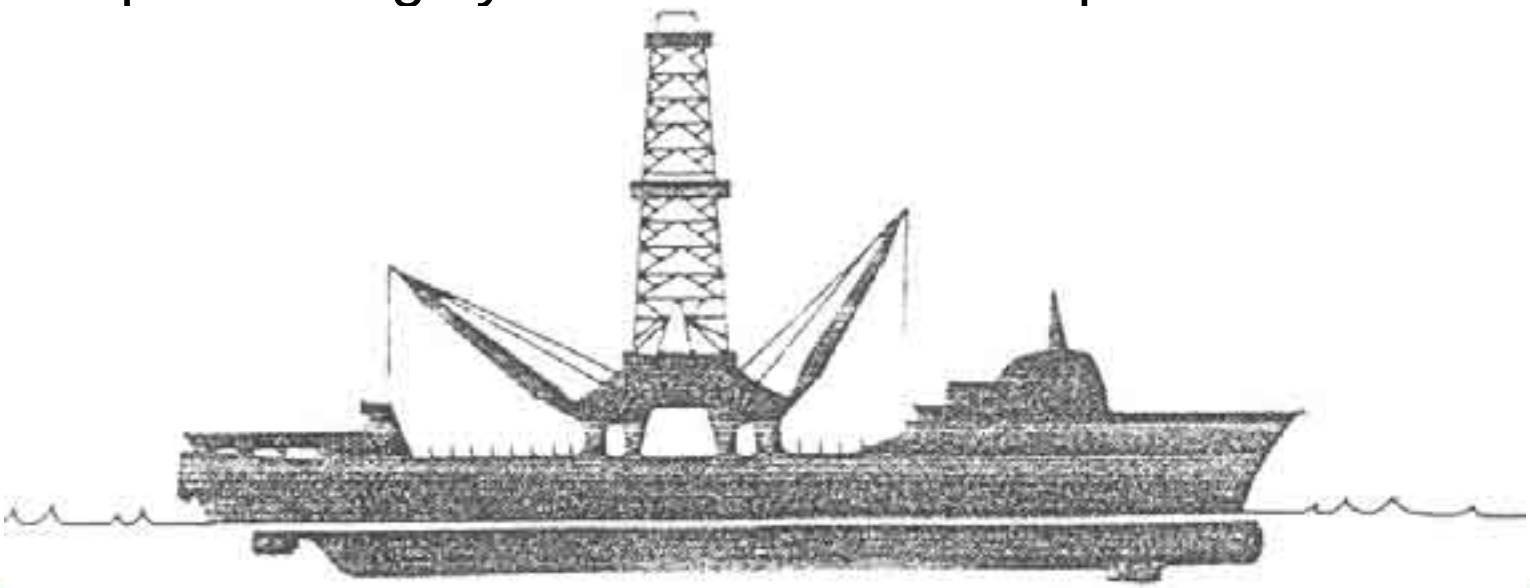
Semi-submersible can be used in depths from 180 to 1800 m.



7. Marine drilling

Drillships, a maritime vessel that has been fitted with drilling apparatus. It is most often used for exploratory drilling of new oil or gas wells in deep water but can also be used for scientific drilling.

It is often built on a modified tanker hull and outfitted with a dynamic positioning system to maintain its position over the well.



7. Marine drilling

8. Statistical data

Active drilling plants to survey hydrocarbon

	1985	1990	1995	2000	2002	2003	2004
Abu Dhabi	20	13	13	11	14	14	11
Arabia Saudita	8	11	19	26	33	34	34
Iran	20	17	22	27	34	35	40
Iraq	25	—	—	—	—	—	—
Kuwait	7	—	5	11	7	9	12
Siria	26	13	15	18	24	25	23
Altri	25	27	29	51	75	75	102
Totale Medio Oriente	131	81	103	144	187	196	199
India	64	135	65	51	59	62	76
Indonesia	74	54	41	34	51	49	51
Altri	98	68	59	47	52	64	54
Totale Asia	236	257	165	132	162	175	181
Algeria	41	35	28	17	22	20	20
Egitto	41	14	21	21	25	26	31
Libia	34	15	13	6	10	10	10
Altri	48	44	36	25	23	28	40
Totale Africa	164	108	98	69	80	84	101
Italia	44	23	11	7	5	5	5
Norvegia	13	15	17	24	15	16	14
Olanda	20	11	11	5	5	3	4
Regno Unito	68	46	32	19	23	15	16
Altri	96	35	51	34	32	30	24
Totale Europa (*)	241	130	122	89	80	69	63
Canada	421	147	251	391	349	404	440
Stati Uniti	1.898	1.086	763	1.116	862	1.106	1.242
Totale Nord America	2.319	1.233	1.014	1.507	1.211	1.510	1.682
Centro e Sud America	439	266	270	257	219	273	306
Oceania	36	21	18	14	14	15	19
TOTALE MONDO (*)	3.566	2.096	1.790	2.212	1.953	2.322	2.551

Egypt: 31