Origin, source rocks and migration of petroleum

Petroleum is liquid consisting of organic molecules composed of hydrogen and carbon. Petroleum term is derived from Latin words Petra (rock) and Oleum (oil).

How is petroleum made?

- Organic matter accumulated with mud in stagnant water.
- Oxygen deficient environment.
- Compaction of mud, expelling the water.
- Bacterial and chemical reaction under sufficient and pressure over millions of years.

oil forms from the decay and transformation of dead organisms buried in sedimentary rocks.

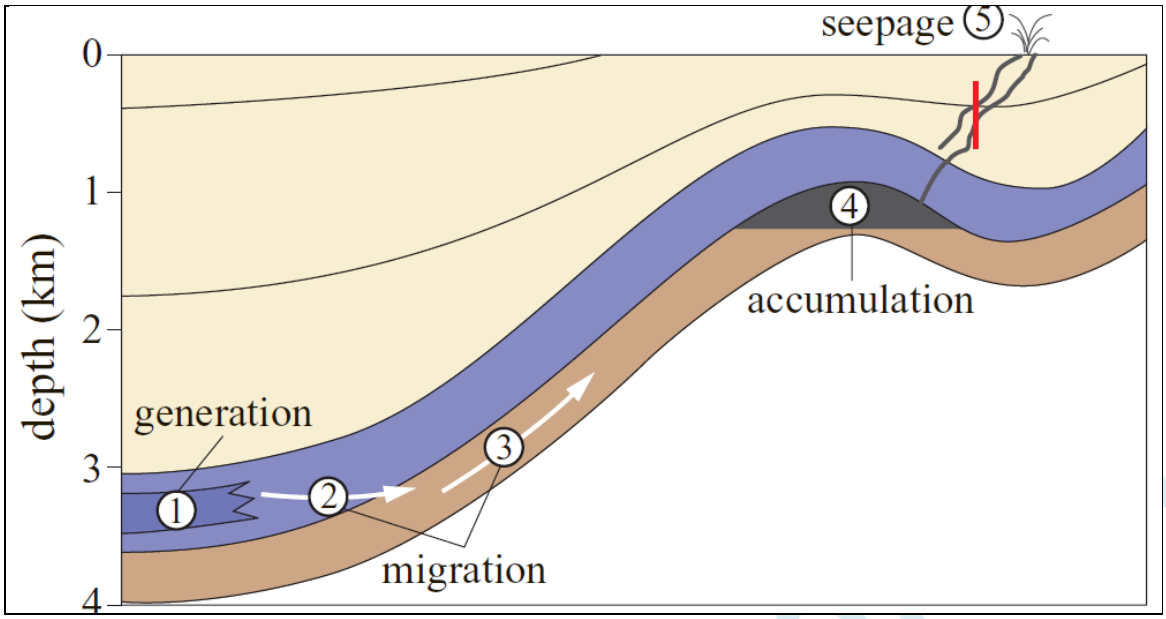
Petroleum source rocks

Petroleum source beds are fine grained, clay-rich siliclastic rocks (mudstones, shales) or dark coloured carbonate rocks (limestones, marlstones), which have generated and effectively expelled hydrocarbons. it must have a sufficient content of finely dispersed organic matter of biological origin; this organic matter must be of a specific composition, i.e. hydrogen-rich; and the source rock must be buried at certain depths and subjected to proper subsurface temperatures in order to initiate the process of petroleum generation by the thermal degradation of kerogen.

Good quality petroleum source rocks can be deposited in marine or lake environments as organic-matter-rich muds providing that bottom waters are oxygen-deficient, i.e. that reducing conditions prevail.
Oil and gas are generated by the thermal degradation of kerogen in the source beds. With increasing burial, the temperature in these rocks rises and, above a certain limit temperature, the chemically portion of the kerogen begins to transform into petroleum compounds.

Migration of petroleum

Transitional stage between place of oil origin and place oil collect. It divided to two parts **primary migration** migration and transmission of oil from the source rocks to the reservoir rocks and **Secondary migration** is the movement of oil inside the reservoir.



1) petroleum generation in source rocks; 2) primary migration of petroleum; 3) secondary migration of petroleum; 4) accumulation of petroleum in a reservoir trap; 5) seepage of petroleum at the Earth's surface as a consequence of a fractured cap rock.

Factors that lead to the petroleum migration:

1. Low porosity of Petroleum-bearing sediments because continuous sedimentation above it.
2. Pressure difference resulting from the earth movements.
3. Extreme pressure generated by natural gas over oil.
4. Capillary if petroleum move vertically up through pores.

The evidence that supports the migration of petroleum:

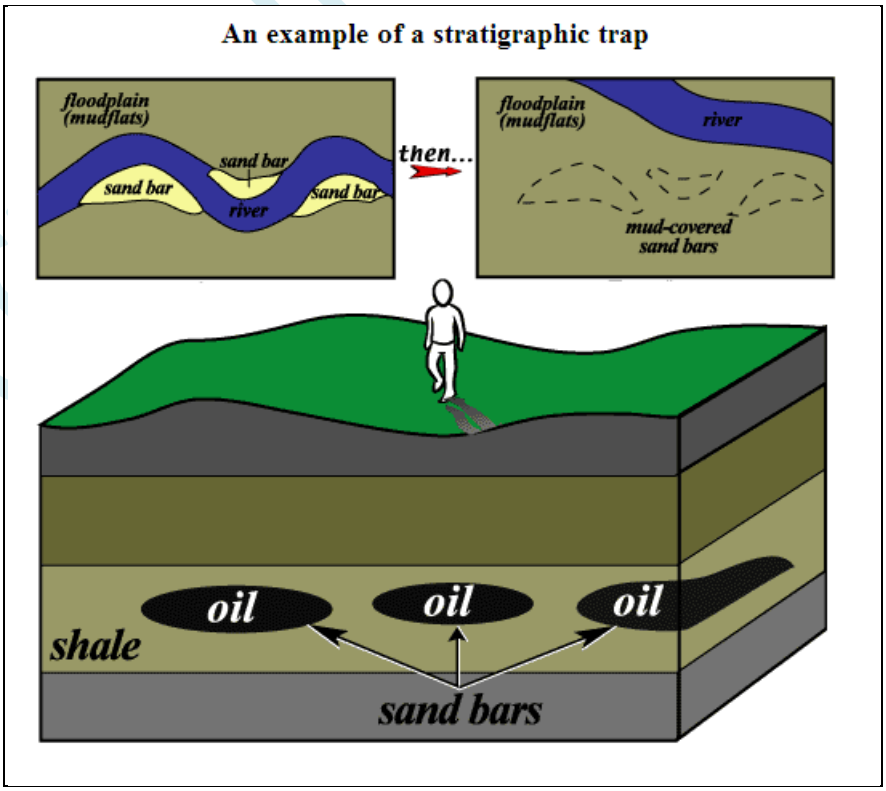
1. Appear oil on earth surface in the form of petroleum nominated.
2. The presence of oil is always in the sandstone rocks and limestone (source rocks usually is mud).
3. The presence of oil in small quantities sometimes in igneous rocks.

Petroleum traps

Trap is geometric pattern layers of sedimentary allows oil or gas or both to assemble in economic quantities, and prevents escape them, and take this geometric pattern several forms, but remain the main feature of the trap is the presence of porous rock covered impermeable rocks . Water is a key factor in guiding the oil and gas to trap in the majority of cases, as it helps in removing oil and gas to wells holes in the production stage.

Petroleum traps are divided into two types:
1.Stratigraphic oil traps.
2.Structural traps.

1. Stratigraphic oil traps:
   The term "stratigraphy" basically means "the study of the rocks and their variations". One thing stratigraphy has shown us is that many layers of rock change, sometimes over short distances, even within the same rock layer. As an example, it is possible that a layer of rock which is a sandstone at one location with siltstone or a shale. we learned that sandstones make a good reservoir because of the many pore spaces contained within. On the other hand, shale, made up of clay particles, does NOT make a good reservoir, because it does not contain large pore spaces. Therefore, if oil migrates into the sandstone, it will flow along this rock layer until it hits the low-porosity shale. A stratigraphic trap is born.

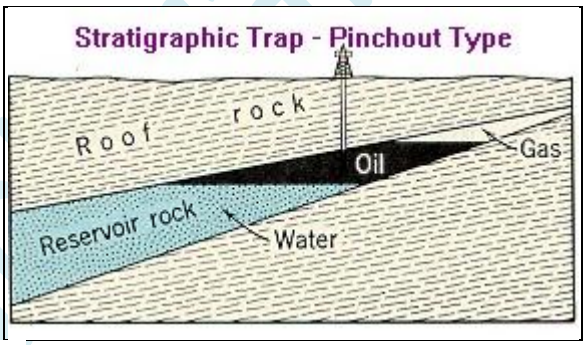


The above series of diagrams is an attempt to illustrate a type of stratigraphic trap. In the diagram at the upper left, we see a river that is meandering. As it does so, it deposits sand along its bank. Further away from the river is the floodplain, where broad layers of mud are deposited during a flood. Though they seem fairly constant, rivers actually change course frequently, eventually moving to new locations. Sometimes these new locations are miles away from their former path.
In the diagram at the upper right, we show what happens when a river changes its course. The sand bars that were deposited earlier are now covered by the mud of the new floodplain.
These lenses of sand, when looked at from the side many years later (the bottom diagram), become cut off from each other, and are surrounded by the mud of the river's floodplain - which will eventually turn to shale. This makes for a perfect stratigraphic trap.

Examples of Stratigraphic Traps:

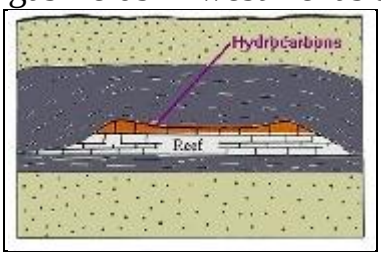
1)pinchout:

Are the result of the changes in deposition of the sediment. Thick layers of mud are covered by thinner layers of sand from migrating shoreline, or by the sand deposited by large rivers. As sea level changes, or rivers migrate, the different sand and mud layers are interwoven creating lenses or pinch-outs. These sand layers allow the petroleum to accumulate and the mud rock layers trap the petroleum. can create traps by burying truncated sandstone or limestone layers with layers of mudstone.



2) Carbonate Reef:

Are great places to trap oil. The open cavities between the corals create excellent reservoirs, and when the reef is buried by mud, the oil becomes trapped. Many of the large oil and gas fields in west Texas are found in buried reef.

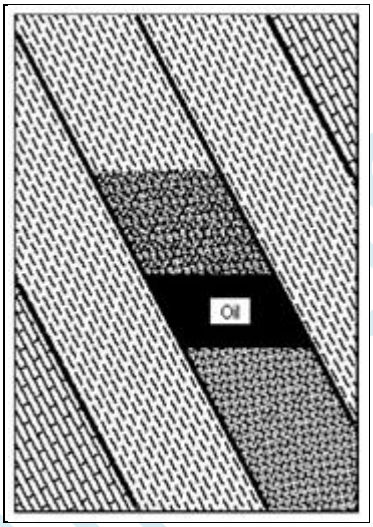


3)Sandstone Lens:

Lenses - Layers of sand often form lens like bodies that pinch out. If the rocks surrounding these lenses of sand are impermeable and deformation has produced inclined strata, oil and natural gas can migrate into the sand bodies and will be trapped by the impermeable rocks. This kind of trap is also difficult to locate from the surface, and requires subsurface exploration techniques.

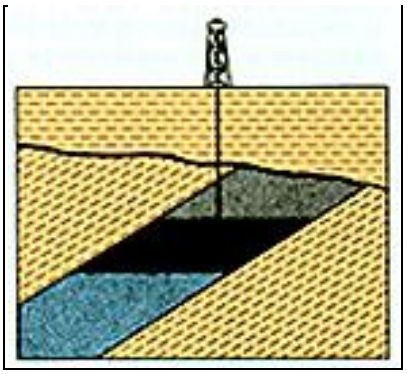
4) Faces Change:

Consider the deposition near a shoreline of a continent, as distance from the shoreline increases. From the shoreline out into the body of water, the particle size decreases from gravel to pebbles, to sand, to silt, to mud.



5) Unconformity trap:

Traps are resulting from unconformity where reservoir covering with impermeable layers of rock.



2.Structural traps:

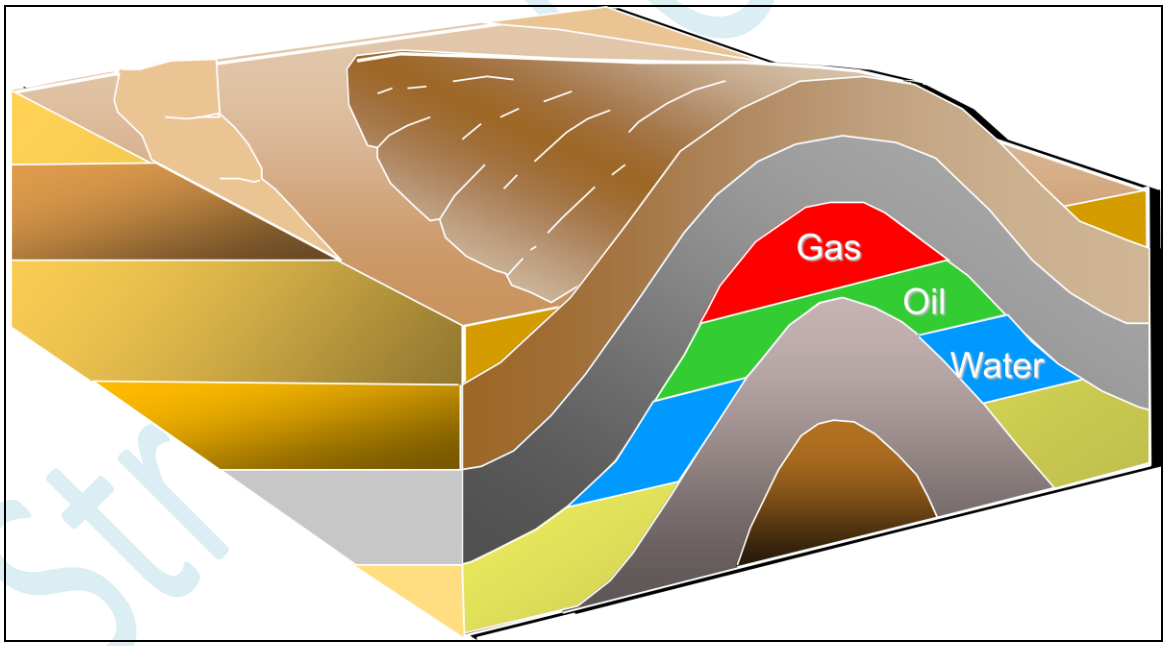
This type of traps are the result of deformation of the rock layers resulting from the stresses and ground movements. There are three basic forms of a structural trap in petroleum geology:

- Anticline Trap
- Fault Trap
- Salt Dome Trap

The common link between these three is simple: some part of the earth has moved in the past, creating an impedence to oil flow.

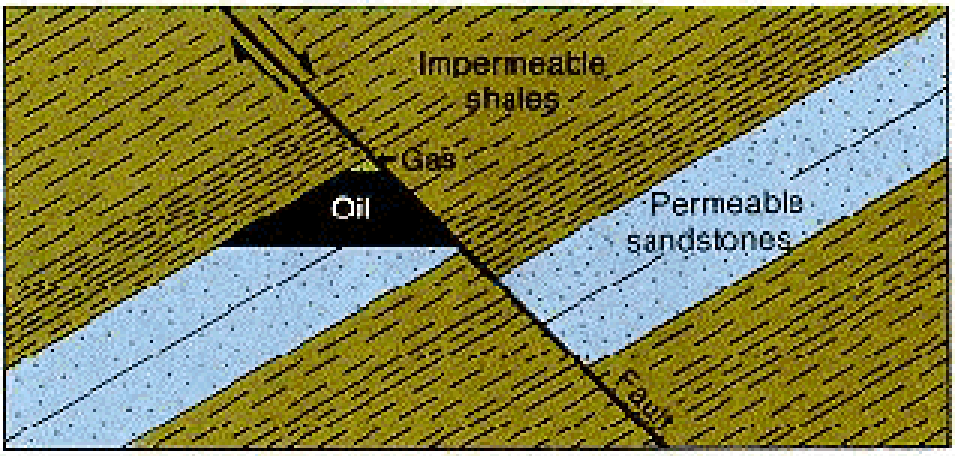
Anticline trap:

An anticline is an example of rocks which were previously flat, but have been bent into an arch. Oil that finds its way into a reservoir rock, the low density of petroleum causes it to buoyantly migrate upward to the highest parts of the fold, until stopped by a low-permeability barrier such as an impermeable stratum or fault zone.



Fault trap:

Fault traps are formed by movement of rock along a fault line. In some cases, the reservoir rock has moved opposite a layer of impermeable rock. The impermeable rock thus prevents the oil from escaping.



Salt Dome Trap:

Salt is a peculiar substance. If you put enough heat and pressure on it, the salt will slowly flow, much like a glacier that slowly but continually moves downhill. Unike glaciers, salt which is buried kilometers below the surface of the Earth can move upward until it breaks through to the Earth's surface, where it is then dissolved by ground- and rain-water. To get all the way to the Earth's surface, salt has to push aside and break through many layers of rock in its path. This is what ultimately will create the oil trap.