Introduction

What is Petroleum ?

Petroleum literally mean(rock oil). The world comes from the Latin world (petra) meaning rock and the world (oleum) meaning oil.

The oil we find underground is called crude oil.

Crude oil is made of mixture of different chemicals called hydrocarbons .

These were produced when tiny plants and animals decayed underground layers of sand and mud.

The crude oil is often mixed with gasses and water.

Oil and Gas are natural resources' of enormous economic importance.

Together they provide about 60% of all the energy used by society today.

Origin of petroleum

What exactly are oil and gas?

Oil and gas are complicated mixtures of different hydrocarbons.

The hydrocarbons is a large organic molecule.

Short chain hydrocarbons like methane are gases .

Medium chain hydrocarbons like paraffin are liquids.

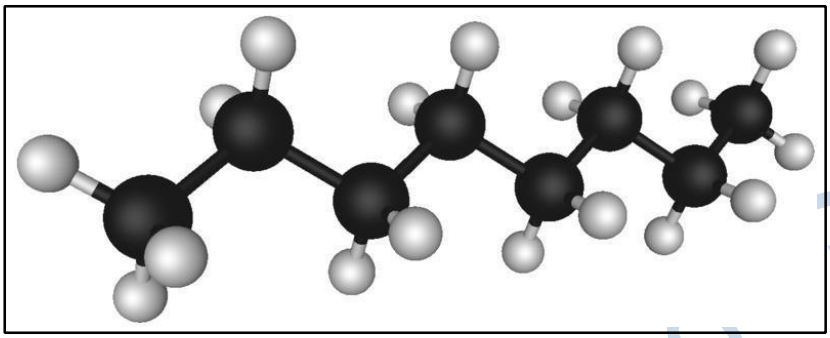
Long chain hydrocarbons like bitumen are solids.

When crude oil is extracted from the earth it may be a mixture of hydrocarbons in solids ,liquid and gas states .

Origin (1): Chemistry

Oil and gas are made of a mixture of different hydrocarbon, As the name suggests these are large molecules made up of hydrogen atoms attached to a backbone of carbon.

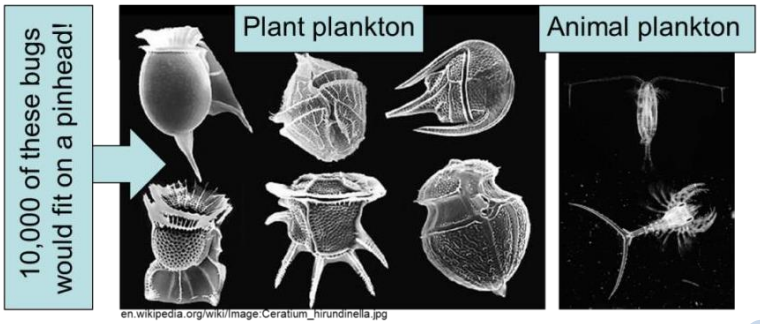
Hydrocarbon



Origin (2): Plankton

It may come as a surprise but most of the world's oil and gas is made up of the fossil remains of microscopic marine plants and animals. That's why oil and gas are often referred to as a fossil fuel. One of the most important group of plankton involved in the formation of oil and gas are single-celled marine 'plants' called dinoflagellates, though many types of animal plankton are also important. Some oil and gas may have also originated from the remains of land plants, but we will not discuss these types of deposits in this talk.

Origin (2): Plankton



- Most oil and gas starts life as microscopic plants and animals that live in the ocean.

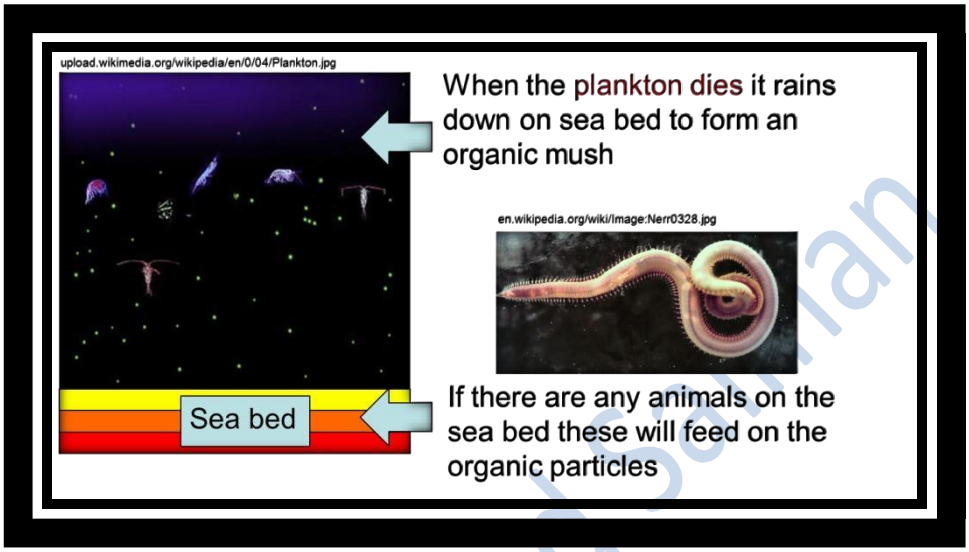
Origin (3): Blooms

In certain parts of the world's oceans, plankton occurs in enormous quantities, or **blooms**. Exactly where those plankton blooms occur is controlled by ocean currents. The richest sites are where cold, nutrient rich waters rise to the surface from the deepest parts of the ocean. The nutrients found in these 'upwelling zones' feed plankton and allow them to reproduce quickly. A single liter of seawater may contain several million dinoflagellates. Where these plankton occurs in high numbers they may turn the water red. This phenomenon is known as red tide.

Dinoflagellate bloom

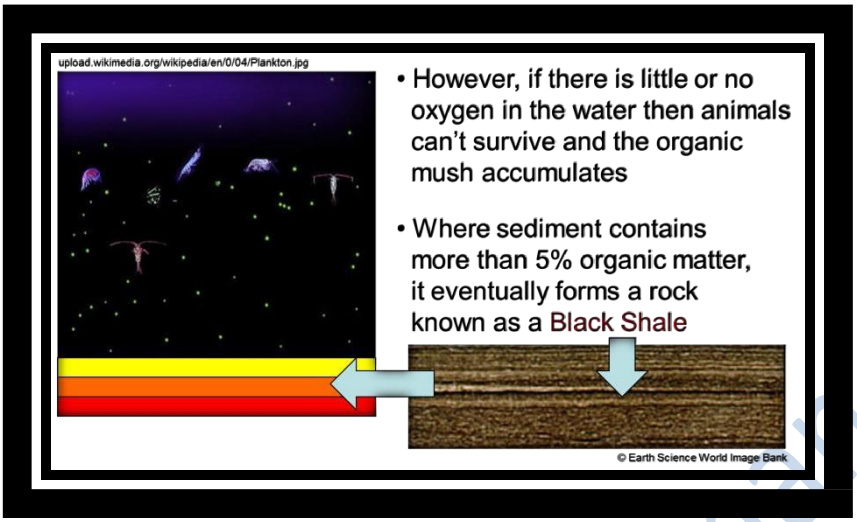
Origin (4): On the sea bed

When plankton dies it slowly settles to the sea bed where it forms an organic mush. Usually there are lots of animals living on the sea floor that feed on this material. One important group is the polychaete worms. These are detritivores, which means they eat the dead and decay remains of other organisms.

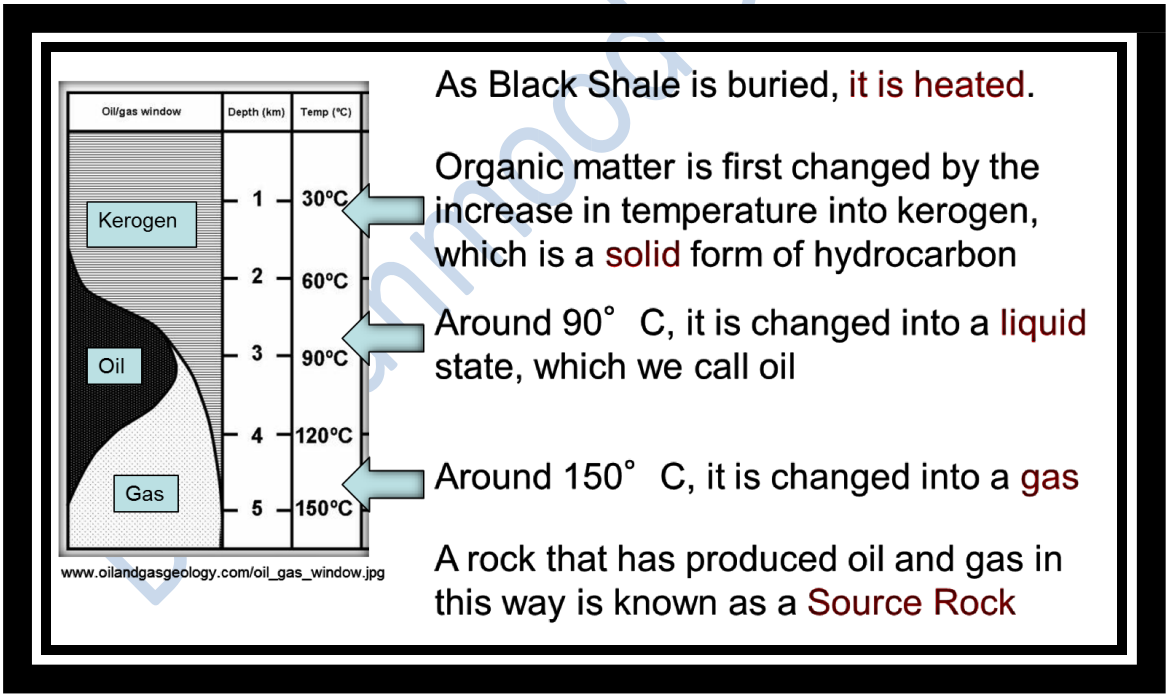


Origin (5): Black Shale

However, under certain conditions there may be very little oxygen on the sea floor. This may be because the ocean is deep and stagnant and oxygen has not been mixed down from the surface waters. No animal life can survive where the sea bed is completely lacking oxygen. Without animals to eat the dead plankton, the organic mush builds up on the sea bed. Where ocean sediment contains more than 5% organic mush it eventually forms a rock known as a Black Shale. The black colour comes from the dark organic matter that it contains. As we will see, Black Shale is what makes oil and gas.



Origin (6): Cooking



As more sediment accumulates on top, layers of Black Shale become buried more and more deeply in the Earth's crust. As they do so, they slowly heat up because of the geothermal gradient. With progressive heating the organic material in the plankton undergoes chemical and physical changes. It gradually breaks down into smaller and smaller hydrocarbons. At temperatures of around 30°C, a solid, sticky

bitumen is produced. Around 90°C liquid oil is formed. As temperatures reach 150°C, natural gases like methane are given off. A Black Shale that is heated and gives off oil and gas is known in the oil industry as a Source Rock.

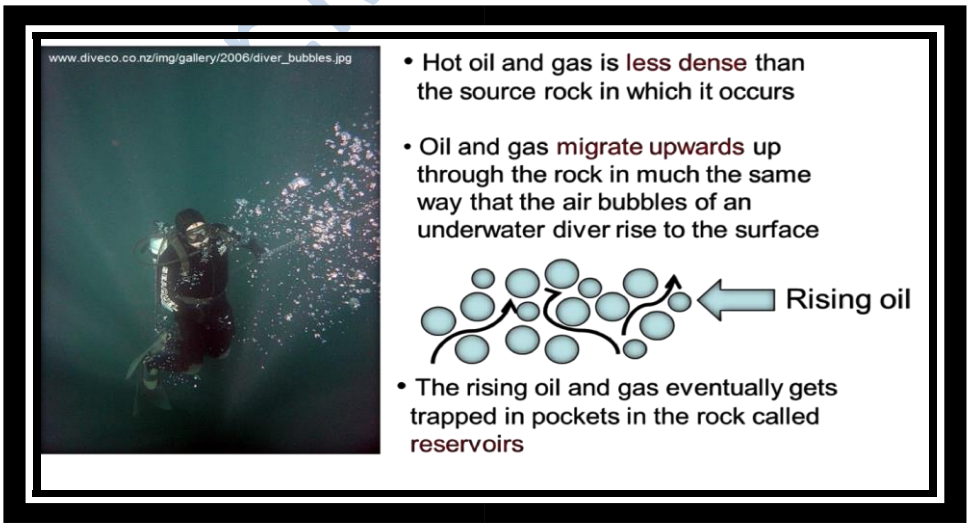
This is natural chemical 'cracking' of the hydrocarbons – where the initially large molecules are broken into progressively smaller molecules by the increase in temperature – much the same as long chain hydrocarbons can be 'cracked' commercially.

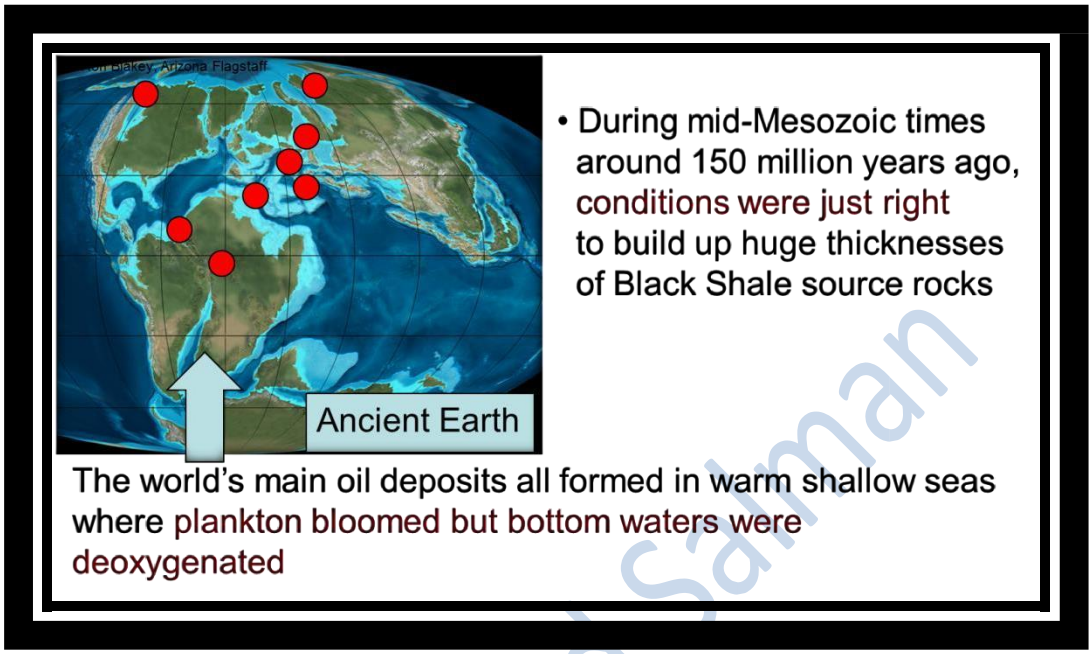
Origin (7): Migration

Migration and accumulation of oil and gas

The hot oil and gas does not stay in the Source Rock for long. As the hydrocarbons are less dense than the water in the source rocks that surround them, they gradually migrate upwards through the rock in much the same way that the less dense air bubbles of an underwater diver will rise through water.

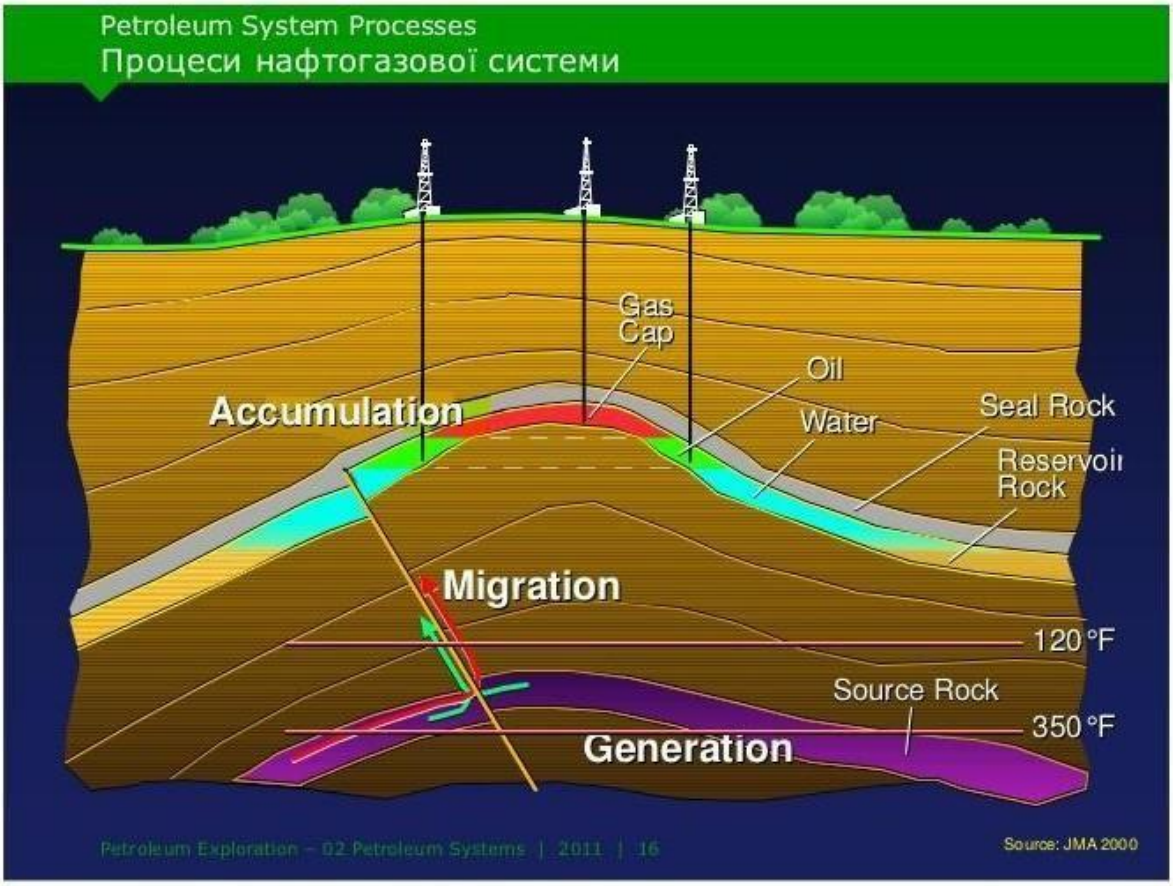
The migrating oil and gas may travel up through the spaces between the sand grains that make up the rock (called pores) or they may find their way up through cracks, fissures, and faults in the overlying rocks. As we will see when we look at oil exploration, eventually oil and gas get trapped in pockets of rock known as reservoirs.

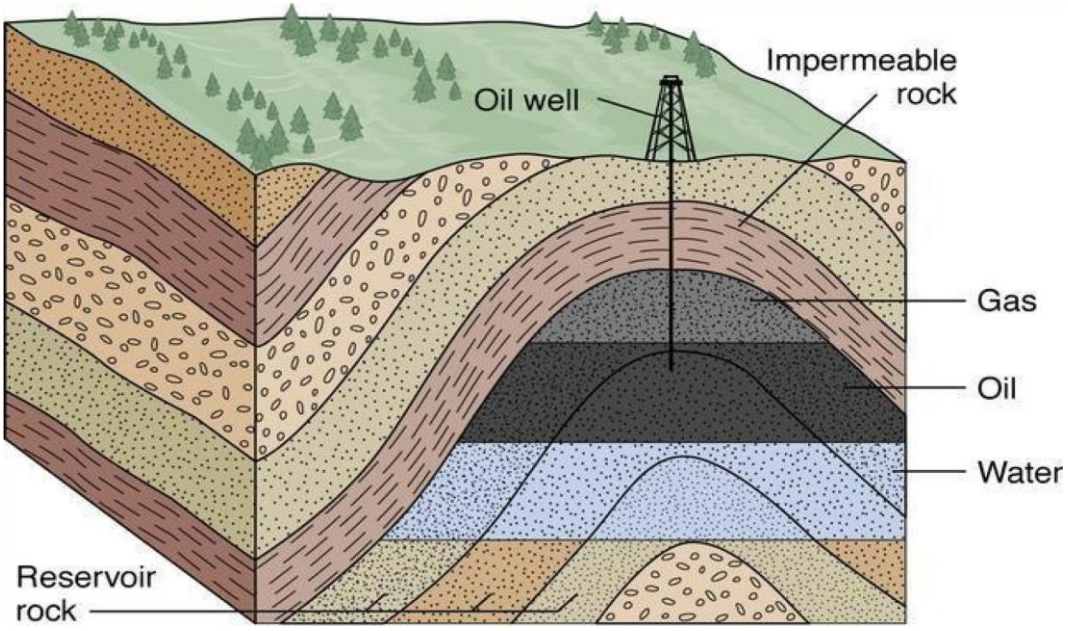




Origin (8): Ancient Earth

Most of the Source Rocks that gave rise to our present day oil and gas fields were formed in the middle of the Mesozoic Era about 150 million years ago. At that time conditions were just right to build up huge thicknesses of Black Shale. On the one hand, the oceans were unusually warm, promoting vast plankton blooms. On the other hand, oxygen was mostly absent on the ocean floors so most of the plankton that settled on the bottom accumulated. There were no animals around to eat it up. The map on the left hand side shows what the Earth looked like 150 million years ago. The red circles show where the world's main oil deposits were formed in warm, shallow, deoxygenated seas.


Petroleum System Processes
Процеси нафтогазової системи
Gas Cap
Oil
Water
Seal Rock
Reservoir Rock
Accumulation
Migration
120 °F
Source Rock
350 °F
Generation
Petroleum Exploration – 02 Petroleum Systems | 2011 | 16
Source: JMA 2000


Oil well
Impermeable rock
Gas
Oil
Water
Reservoir rock