Basic Information about Oil and Gas

Outline

- What is Petroleum?
- How is oil formed?
- What is Oil used for?
- Oil Composition
- Oil Properties

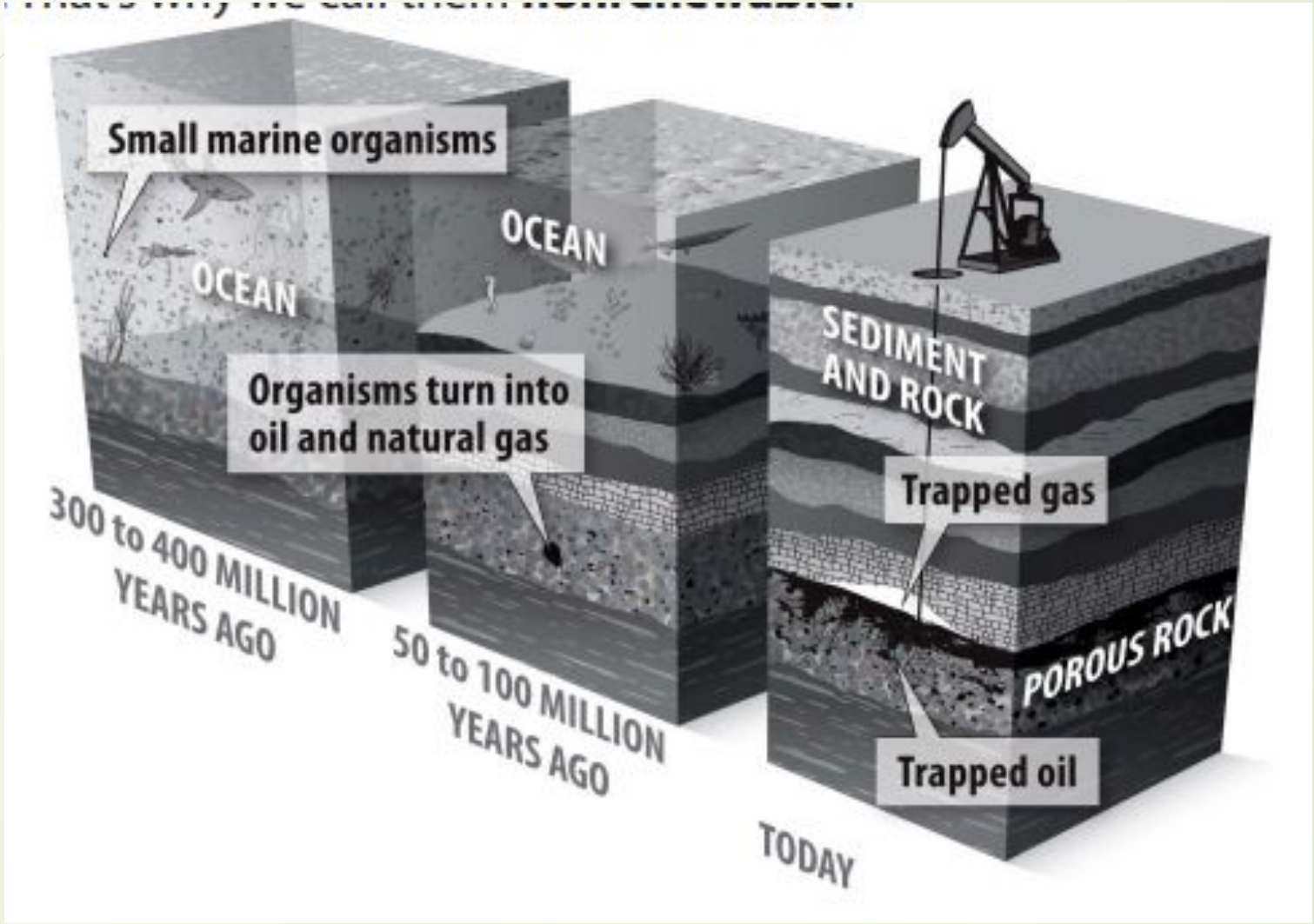
What is Petroleum?

- **Petroleum: a complex mixture of naturally occurring hydrocarbon compounds found in rock.**
- **Petroleum Latin word (“Petra” means rocks, “oleum” means oil)**
- **Solid, gas or liquid**
- **Petroleum generally refers to liquid crude oil**
- **Crude Oil: A general term for unrefined petroleum or liquid petroleum.**

How is Oil formed?

- **Oil was formed from the remains of animals and plants that lived millions of years ago in a marine (water) environment.**
- **Over the years, the remains were covered by layers of mud.**
- **Heat and pressure from these layers helped the remains turn into what we today call crude oil.**

How is Oil formed?



What is Oil used for?

- **90% of all transportation fuels**
- **Lipstick**
- **Aspirin**
- **Artificial Heart**
- **Shampoo**

Oil Composition

- Hydrocarbons – 98%
  - Alkanes
  - Cycloalkanes
  - Aromatic HCs
- Non-hydrocarbon components < 1%
  - sulphur, nitrogen, oxygen and heavy metals (Vanadium, Nickel, Copper, Zinc and Iron)
  - but their influence on the product quality can be considerable

Hydrocarbon Chemistry

Classification:

- **Arrangement of the carbon molecules**
  - **Open Chain**
  - **Cyclic**
- **Number of Bonds between carbon molecules:**
  - **Saturated (Alkanes)**
  - **Unsaturated (Alkenes, Alkynes)**

Alkanes

Under Standard Conditions (Temperature 298K and Pressure 1 atm)

- **C1 – C4 are gases**
- **C5 – C17 are liquids**
- **>C17 are solids**

Alkanes

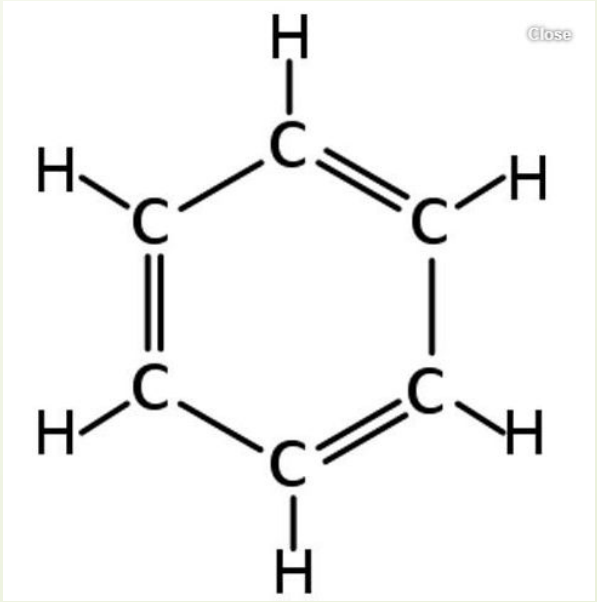
- CH_4 *to* $C_{40}H_{82}$ *in crude oil*
- 20 % of oil by volume
- Inert
- Alkenes and alkynes are Reactive (uncommon in crude oil)

Alkanes

- At reservoir - Long chain of HCs may exist in solution
- At tubing and surface facilities - Long chain of HCs may solidify
- The detailed laboratory analysis of the crude oil composition is required
- Cyclic HCs are common in crude oil

Aromatic Hydrocarbons (Arenes)

- Carbon atoms are connected by alternating double and single bonds
- Benzene



Non-Hydrocarbon Components of Petroleum Fluids

- Typically < 1%
- Significant Impact on Product Quality and Processing Requirement

Non-Hydrocarbon Components of Petroleum Fluids

- Sulphur - 0,2 % to 6% (average 0,65 %)
- Highly Corrosive and Toxic
- Corrosive: Free Sulphur, Hydrogen Sulphide (H2S), and other carbon compounds with Suphur.
- Natural Gases – H2S

Non-Hydrocarbon Components of Petroleum Fluids

- Nitrogen <0,2%, high as 2%
- Reduces Caloric Value
- Oxygen can produce corrosive compounds
- Carbon Dioxide + Water = Carbonic Acid
- Metals: Vanadium, Nickel, Copper, Zinc and Iron.

Oil Properties

- Crude oil properties can vary widely depending on where the oil is found and under what conditions it was formed
- The properties of oil include its density, called the API gravity (named after the American Petroleum Institute)

Specific Gravity of a Liquid

- The specific gravity of a liquid is the ratio of its density to that of water

$$\gamma_o = \frac{\rho_o}{\rho_w}$$

API gravity

$$^{\circ}\text{API} = \frac{141.5}{\gamma_o} - 131.5$$

- **the lower its density, the higher its API gravity**

Light and Heavy Oil

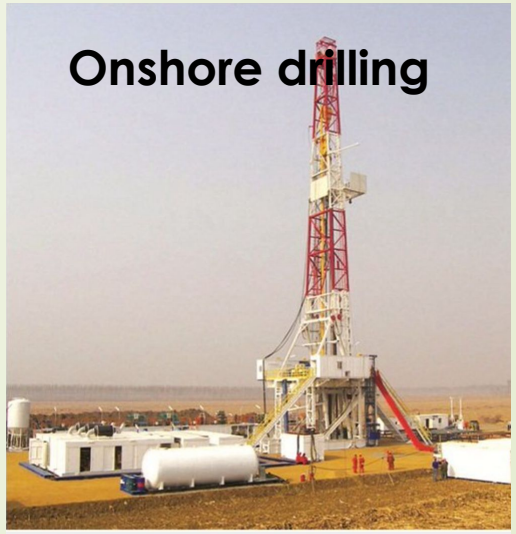
- **Crude oil can be classified as either light or heavy depending on its API gravity (or density).**
- **Heavy: 10–20° API gravity- quality of oil less**
- **Light: above 25° API gravity- quality higher**

Sour and Sweet Oil

- **Crude oil can also be classified as either sour or sweet, depending on the amount of sulphur it contains.**
- **Oil with a high sulphur content (0.5% and above, by weight) is considered sour.**
- **Sweet crude oil, on the other hand, has low amounts of these sulphur compounds.**

Onshore and Offshore field

- **Onshore field: fields on dry land (Tengiz Oil Field)**
- **Offshore field: fields in the middle of sea (Kashagan Field)**



Oil and Gas Field Phases

- **The life of an oil or gas field can sub-divided into the following phases:**
  1. **Exploration**
  2. **Appraisal**
  3. **Development**
  4. **Production**
  5. **Abandonment**

Exploration

- Exploration is a process of finding regions which there might be oil by analyzing available information.
- Exploration is almost like a detective work which requires looking for clues, careful observation, taking notes of different information and evaluation of survey data.
- This is the job of petroleum geoscientists who are experts on rocks.
- Petroleum geoscientists begin looking for places where there might be oil.
- They look for signs that might indicate the presence of oil.

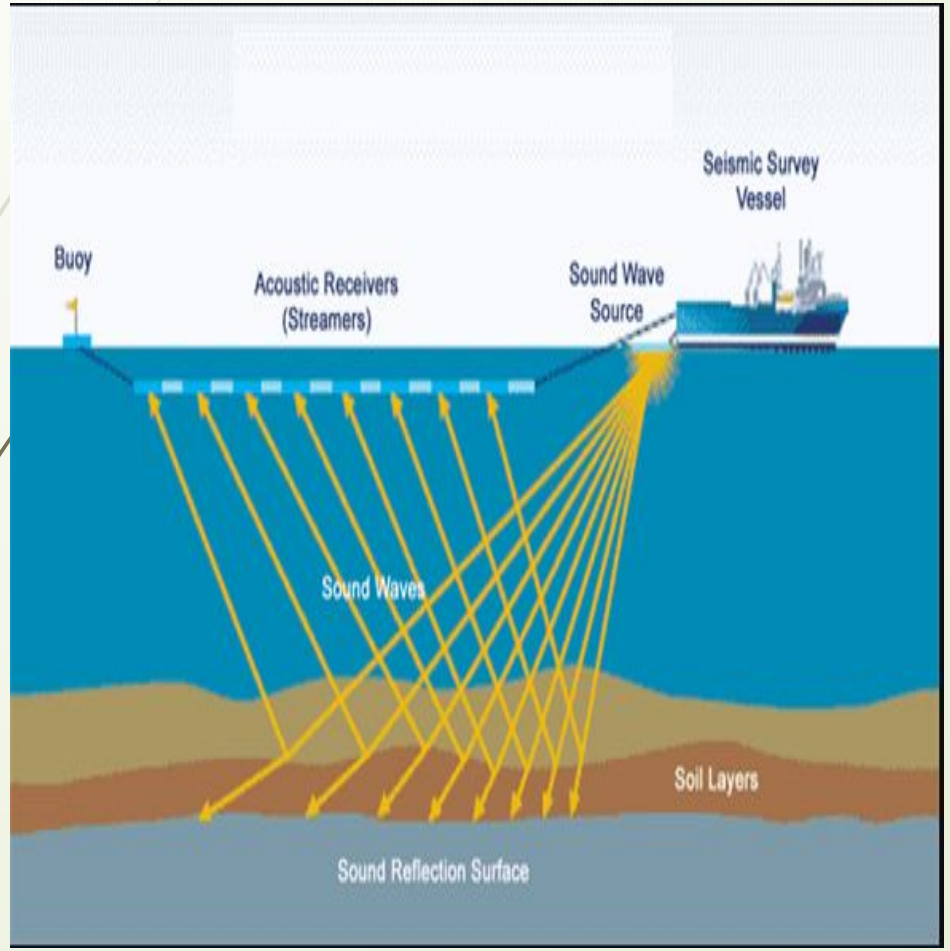
Exploration

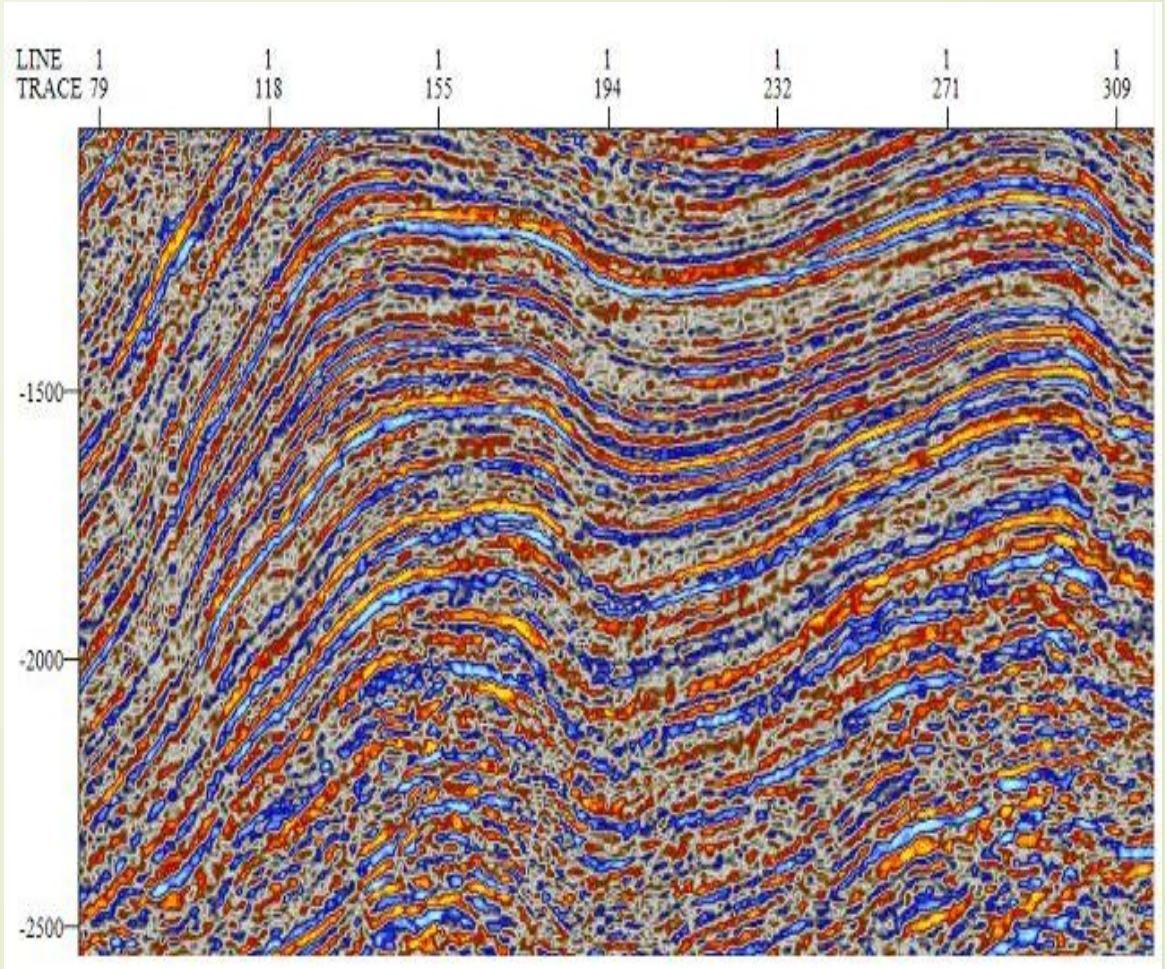
- Geoscientists should create the picture of underground, and figure out how everything is organized underground.
- They use special tools in order to see the rocks underground.
- Most commonly they use seismic technology

Seismic Technology

- **The working principle of seismic is based on shock waves created by an explosion or sound generator.**
- **These waves travel beneath the surface of the Earth and reflected back by the various rock layers.**
- **The reflections travel at different speed depending upon on the type of rock layers through which they pass.**
- **So geophysicists interpret the readings for signs of rocks which might contain oil or gas.**

Seismic Technology





Exploration Well

- The only way to be absolute sure that there is oil in the underground is simply to drill a well.
- Drilling is expensive, the cost of drilling one well can be anything from 1 million to 35 million
- the cost depends on several factors:
  - location of the field (onshore or offshore)
  - the size of the field, the amount of information which is available
  - the type of rocks underground
- So if hydrocarbons are not found there is no return on the investment.
- Therefore there is a large risk involved

Appraisal Phase

- **If the results of exploration look promising, then the company enters the Appraisal phase of the life of the field.**
- **During this phase, more seismic waves may be shot and more wells will be drilled to obtain precise picture of the size, shape and producibility of the accumulation.**

Field Development Plan

- **If the prospect considered to be economically attractive a Field Development Plan will be prepared and submitted for approval to the government.**

Development

- When the approval for development is received then the company will commence drilling Development wells and building production facilities according to the Development Plan.

Production

- **The production phase commences with the first commercial quantities of hydrocarbons ("first oil") flowing through the wellhead.**
- **This marks the turning point from a *cash flow* point of view, since from now on cash is generated and can be used to pay back the prior investments, or may be made available for new projects.**

Abandonment

- **At some point in the life of the field the costs of production will exceed the revenue from the field and the field will be abandoned.**
- **All of the wells will be plugged and all surface facilities will be removed in a safe and environmentally acceptable fashion.**