UNIT 5

EARTH RESOURCES

Hydrocarbon Processing Techniques
Processes and Techniques Involved in Extracting and Refining Hydrocarbons

Key term:

- **Kerogen**
  - a mixture of organic matter in sediments from which petroleum is released.
Processes and Techniques Involved in Extracting and Refining Hydrocarbons

- The three phases in the evolution of organic matter to petroleum.
  1. **Diagenesis**
  2. **Catagenesis**
  3. **Metagenesis**
Processes and Techniques Involved in Extracting and Refining Hydrocarbons

- **Diagenesis:**
  - Shallow burial of organic matter at near normal temperature and pressure as well as some decay.
  - Methane, carbon dioxide, and water are released leaving behind the complex hydrocarbon called kerogen.
Processes and Techniques Involved in Extracting and Refining Hydrocarbons

○ **Catagenesis:**
  - Deeper burial results in increased temperature and pressure.
  - Petroleum is released from the kerogen
    - First oil is released
    - Second gas is released.
Processes and Techniques Involved in Extracting and Refining Hydrocarbons

- **Metagenesis:**
  - Has *even higher temperature* and pressure verging on metamorphism.
  - The *only* hydrocarbon that is released during this phase is *methane*.
  - At this point the petroleum has matured enough to migrate to *traps*. 
Components Involved in the Formation of Petroleum Traps.

(i) source rock
(ii) reservoir rock
(iii) cap rock

As oil migrates it fills up the pores
Source Rock

Must contain an abundance of organic matter.

- Petroleum is often created and released from the source rock during lithification.

Examples: shale and limestone.
Reservoir Rock

- Requires high porosity and high permeability
  - It’s what the petroleum moves through and is stored in.

- Note:
  
  **Porosity** is the **volume** of pore spaces.

  **Permeability** is the inter-connectedness that allowing the movement of the petroleum.
Porosity of a material is influenced by:

i) particle shape - **rounded**
ii) particle size - **Large**
iii) the degree of sediment sorting. - **well-sorted**

*Usually, the higher the porosity and the larger the pore spaces, the higher the permeability.*

Examples of reservoir rocks are: **sandstone, dolomite, and conglomerate**
Cap Rock

- An impermeable rock that traps petroleum from escaping or spreading throughout the rock.

- Note: petroleum exists within reservoir rock between sediment as opposed to being confined as a whole volume of liquid petroleum.

“There are no ponds of petroleum in the ground”. 
Types of Petroleum Traps

(i) anticline trap
(ii) fault trap
(iii) salt dome trap
(iv) stratigraphic trap
Anticline Trap:

- If a **permeable** rock is between **impermeable** rock and are **folded** into an anticline.

- Oil and gas can move upward and **accumulate** in the upper region of the anticline.
Salt Dome Trap

- Salt that has moved up through the Earth,
- It punches and bends rock along the way.
- Oil can fill up the area against the impermeable salt!
Limestone Reef Trap

- Limestone reef trap is a type of stratigraphic trap.
- A coral reefs become buried by impermeable sediments; they can form excellent oil sources and reservoirs.
Note: **Density** is what distributes petroleum in a reservoir.

- Water is denser than oil and oil is denser than gas.
- Therefore, when drilling, **gas, oil and then water**.
- Some have all three, some just 1 or 2
The two main means of extracting petroleum from Earth, include:

(i) **drilling**

(ii) **surface extraction (open pit mining)**
Drilling

- Drilling can take place on land, ice, or water.
- Part of the trap is under pressure.
- When drilled it is released naturally.
- But some remains due to loss of pressure.
- To get the rest out you pump in water, gas etc.
Surface Extraction (open pit mining)

Example: Alberta oil sands, (tar sands)

Petroleum extracted directly from the surface. The petroleum migrated towards the surface - volatiles (water) are lost.

After the volatiles are removed, it becomes viscous (thick), so it doesn't spread out.
Surface Extraction (open pit mining) cont...

- The Sands have loose sediment of high porosity and permeability, but **no cap rock**.
- Fort McMurray’s Athabasca oil sands
Methods of Refining Petroleum.

- Include:

  - **Distillation**

    - Crude oil has hydrocarbons mixed together.

    - The longer the hydrocarbon the **higher the boiling point**, so they can all be separated by distillation (heating and catching evaporates).
(ii) **Cracking**
- Part of distillation where the heat breaks down heavier hydrocarbon molecules into lighter ones like petrol and diesel. (each called a fraction)

(iii) **Reforming**
- This changes hydrocarbons into others, such as gasoline.
  - It uses heat, pressure, and catalysts (speed up reaction rates)
Sustainable Development

- What is meant by sustainable development?
- How it relates to extracting and processing Earth Resources?
- What are economic, the environmental, political/social/cultural aspects relate to extraction of resources?
- Realize that the decisions we make today will impact our future.