

**Lecture on Monday 6-4-2020**

# Hydrocarbon Migration process

# Migration

- Migration is the process of the oil and gas moving away from the source rock.
- This is a slow process *i.e. perhaps a few kilometres over a period of millions of years.*

# Factors control Migration

- 1- Pressure (Burial and Compaction)
- 2- Increase in volume

# 1- Pressure (Burial and Compaction)

- As the source rock is **buried** deeper in the Earth, **increasing pressure** (overburden) of the overlying rocks **compacts** the rock to provide the driving forces to **expel** water, oil and gas.
- The mineral grains don't compact **but** their pore spaces are decreased.
- petroleum generated is therefore squeezed out from the **source rock spaces**.

# 1- Pressure (Burial and Compaction)

- Compaction of the source rock beds **by the weight of the overlying rocks** provides the driving mechanism to expel the hydrocarbons causing them to move, where they will take the easiest route i.e. ( through the most porous beds or fractures) moving to regions of lower pressure ( that normally would be at shallower depths.)

## 2- Increase in volume

- The maturation of a liquid or gas from a solid, causes an increase in volume which may cause fracturing of the source rock.
- The hydrocarbons generated, therefore, escape upwards through such fractures that are created.

# Note

- Water, Oil and gas will only migrate through permeable zones (where spaces between rock particles are interconnected and large enough to allow fluid movement to an entrapment point).
- petroleum is forever trying to rise until it is trapped or escapes at the earth's surface.



# Note

- *When source muds are first deposited they consisted of 70-80% water. What is left are solids such as clay materials, carbonates particles or fine grained silica.*

# Note

- As sediments build up to greater thickness in sedimentary basins, water is squeezed out by the weight of the overlying sediments.
- Under normal hydrostatic pressure ( 0.445 psi/ft ), the clays lose porosity and the pore diameters shrink as shown in the table below.

# Note

<b>Depth</b>		<b>Clay Porosity</b>	<b>Clay Pore diameter.</b>
<b>Meters</b>	<b>Feet</b>	<b>Percent %</b>	<b>Nanometers</b>
<b>610</b>	2,000	27	-----
<b>2,000</b>	5,560	15	10.0
<b>3,000</b>	9,840	9	5.0
<b>4,000</b>	13,120	6	2.5
<b>5,000</b>	16,400	4	1.5

# Note

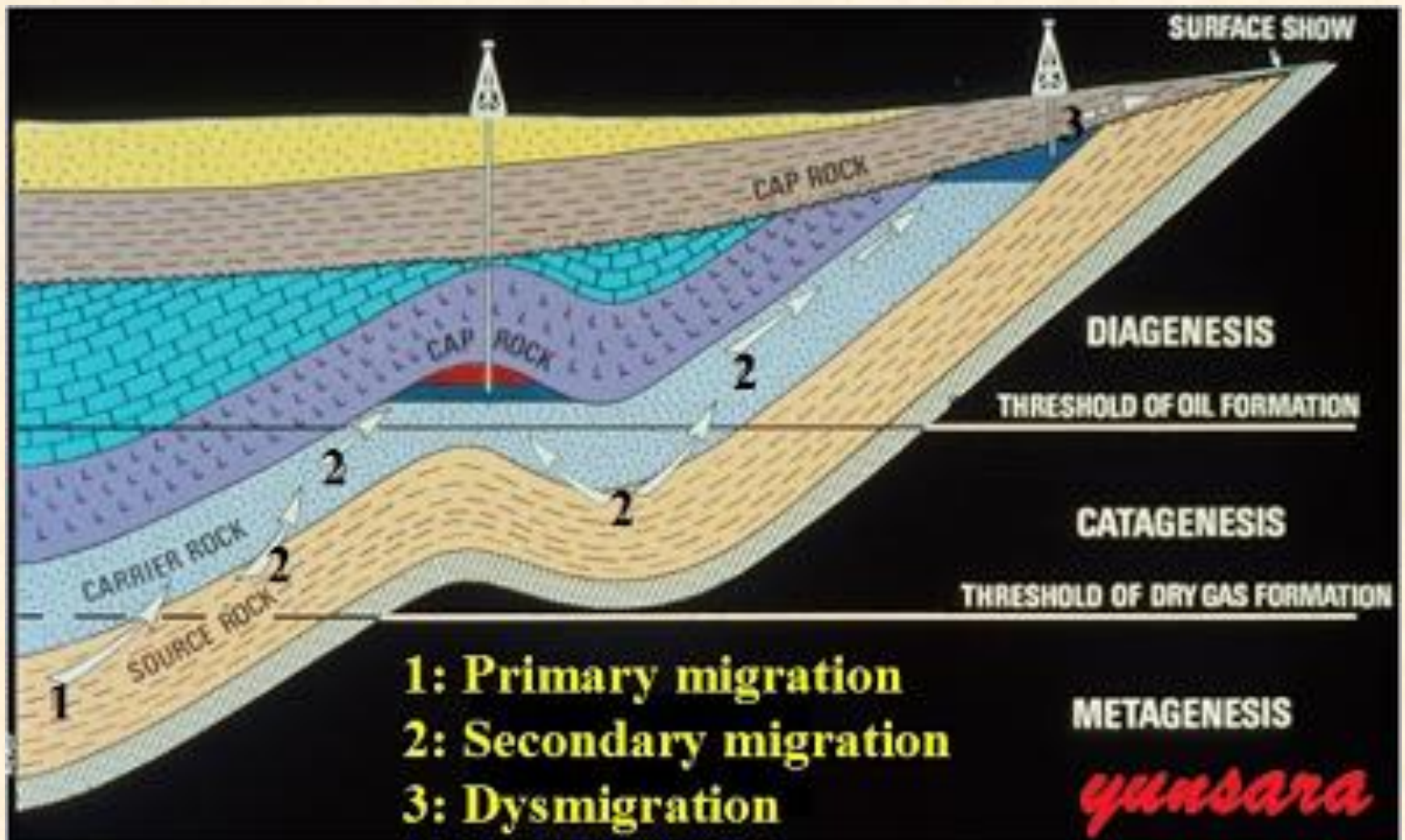
- **Note:** Pore diameters of shale source rocks range from 5 to 20 nm with a corresponding porosity range of 4 to 15%.
- The effective molecular diameters of some HC products are:

Molecule	Diameter (nm)
Water	0.30
Methane	0.38
n-Alkanes	0.47
Cyclohexane	0.48
Complex aromatics	1-3
Asphaltenes	5-10

# Hydrocarbon Migration Types

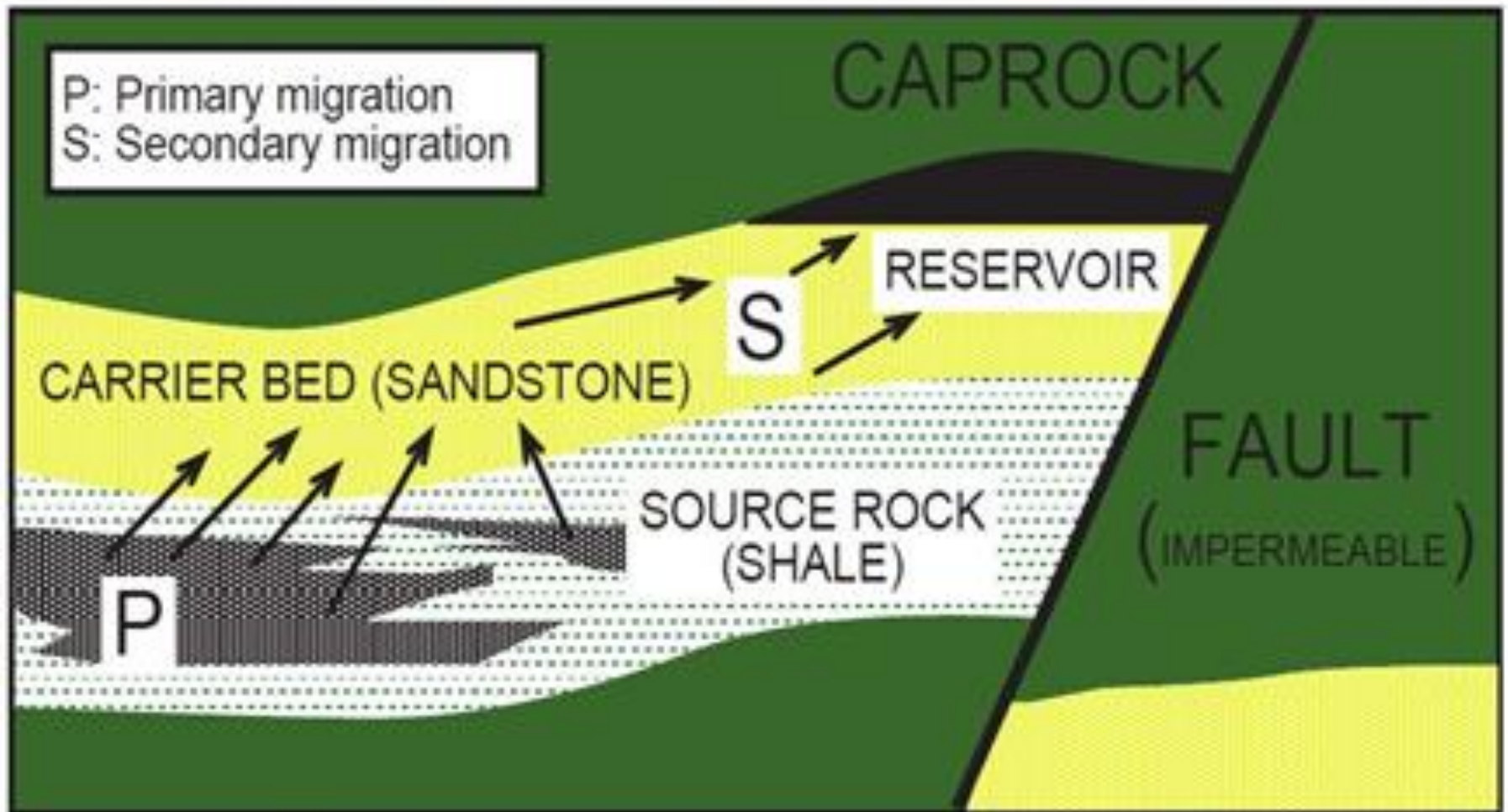
- **Primary migration** is the process of hydrocarbon movement from source rock.
- Note: Primary migration the **transportation of water, oil and gas out of the compacting sediments.**
- **Secondary migration** is hydrocarbon movement within the carrier bed (reservoir) to reach entrapment point.
- ***Tertiary migration*** is movement of a previously trapped oil and gas accumulation.





# Secondary Migration

- In secondary migration, the oil droplets are moved within the reservoir (carrier bed) to form pools.





# Secondary Migration

- **Factors may control the Secondary Migration :-**
- 1- **Buoyancy** causes oil to migrate to the highest permeable part of the reservoir,
- 2- **Capillary forces** direct the oil to the coarsest grained area **first** then successively into finer grained areas **later**.

# Secondary Migration

- 3- **Crustal movements** of the earth may shift the position of the pool within the reservoir rock.
- 4- **Faults** sometimes cut through reservoirs destroying parts or shift them to different depths.
- 5- **Fracturing of the cap rock** may allow accumulations to migrate vertically to much shallower depth.

# Secondary Migration

- **Example:** Vertical migration via **faults** and **fractures** is also possible, this has led to many of the large oil accumulations, such as that found at **shallow depths** (up dip) in **Venezuela and Northern Iraq**.
- ***Uplift and erosion*** bring hydrocarbons nearer to surface where lighter hydrocarbons may evaporate.

# Note

- Wherever differential pressures exist and permeable openings provide a path, petroleum will move.
- Once the water, oil and gas migrates into the trap, it separates according to density.  
(Gas being the lightest, goes to the top of the trap, Oil goes to the middle and water on the bottom)

# Separation

- Gravity separation of gas, oil and water takes place in reservoir rocks that are usually water saturated.

- **Finally The mechanism that oil migrates is uncertain , but it is most likely in solution.**

**Thank you**