2. Migration processes of Oil and gas.

A. Introduction

Potential oil and gas sediments accumulate as a mixture of grains, water and organic content. As they are buried and compacted, fluids and or gas mature and will increase in volume and are squeezed out of the source rocks by the resulting forces that exist.

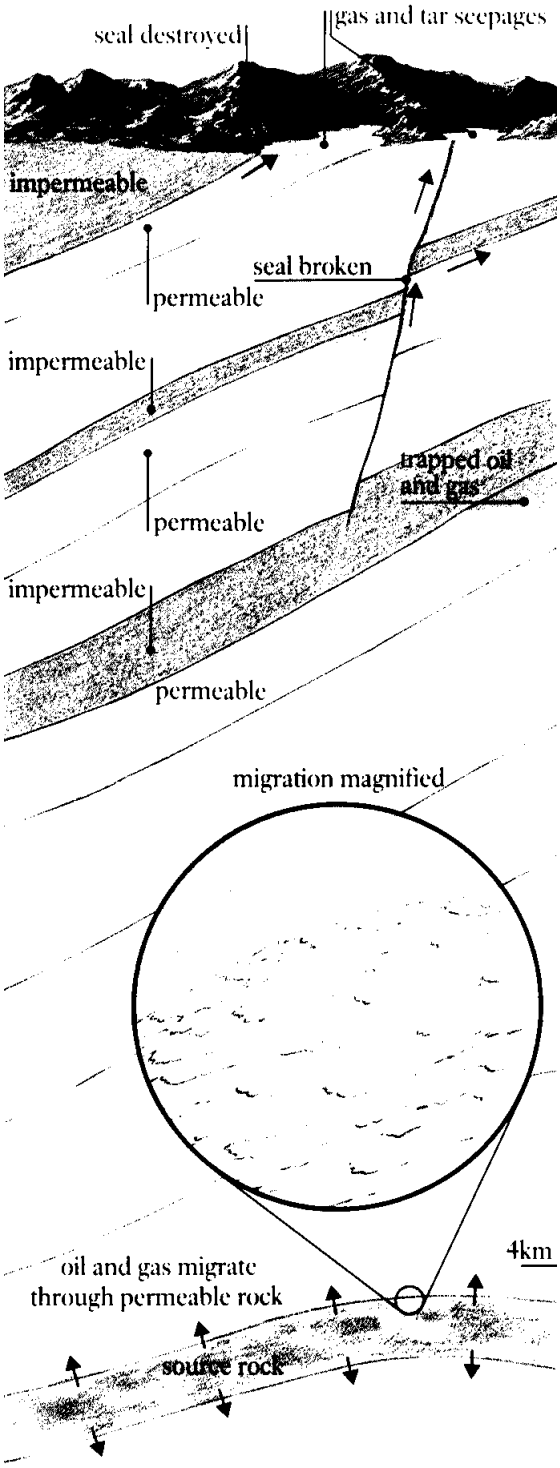
Migration is the process of the oil and gas moving away from the source rock. This is a slow process *i.e. perhaps a few kilometres over a period of millions of years*.

Migration is caused by burial, compaction, and increase in volume and separation of the source rock constituents.

There must be space 'porosity' within the rocks to allow for movement. In addition, there should be 'permeability' within the rocks to allow for flow.

B. Migration processes

MIGRATION



Burial

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

Increase in volume

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

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.)*

Separation

Gravity separation of gas, oil and water takes place in reservoir rocks that are usually water saturated. Consequently, petroleum is forever trying to rise until it is trapped or escapes at the earth's surface. **Note :** Water, Oil and gas will only migrate through permeable enough zones where spaces between rock particles deposited or generated are interconnected and large enough to allow fluid movement to an entrapment point.

Primary and secondary migration

Primary migration is the process of movement from source rock.

Secondary migration is movement to or within the reservoir entrapment.

Kingdom drilling services Ltd

C. Primary Migration

Primary migration the transportation of water, oil and gas out of the compacting sediments. *E.g. 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.*

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.

- Table 1 : Changes during normal compaction of shale's

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

It is also important to note that fluids tend to move toward the lowest potential energy. Initially this is upwards, but as compaction progresses, there is lateral as well as vertical movement.

The primary migration of oil from source to reservoir is as follows

1. Water flows towards the lowest potential energy
2. Clay muds often have abnormal pressure because they are slow to release water
3. Avenues of migration during basing compaction are

    - Sandstone's
    - Unconformities
    - Fracture / Fault systems
    - Biothermal reefs.

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

D. Secondary Migration

In secondary migration, the oil droplets are moved about within the reservoir to from pools. Secondary migration can include a second step during which crustal movements of the earth shift the position of the pool within the reservoir rock.

Accumulations can be affected by several, sometimes conflicting, factors. e.g.

a. *Buoyancy causes oil to seek the highest permeable part of the reservoir, capillary forces direct the oil to the coarsest grained area first then successively into finer grained areas later.*

b. *Any permeable barriers in the reservoir channel the oil into somewhat random distribution.*

c. *Oil accumulations in carbonate rock are often erratic because part of the original void spaces have been plugged by minerals introduced from water solutions after rock is formed.*

d. *In large sand bodies, barriers formed by thin layers of dense shale may hold the oil at various levels. With crustal movement of the earth, accumulations are shifted away from where they were originally placed.*

e. *Faults sometimes cut through reservoirs destroying parts or shift them to different depths.*

f. *Uplift and erosion bring accumulations nearer to surface where lighter hydrocarbons may evaporate.*

g. *Fracturing of the cap rock may allow accumulations to migrate vertically to much shallower depth.*

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 to form the free gas cap. Oil goes to the middle and water that is always present, on the bottom. The oil portion of the trap is saturated with a certain percentage of oil and water.

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 in Bolivar, Venezuela, and Northern Iraq.
In other cases, such as the Khurais filed in Arabia, migration over relatively long distances has to take place by movement up dip within a porous bed until a trap was encountered.