TRAPS: OIL AND GAS ACCUMULATION

WHAT ARE TRAPS

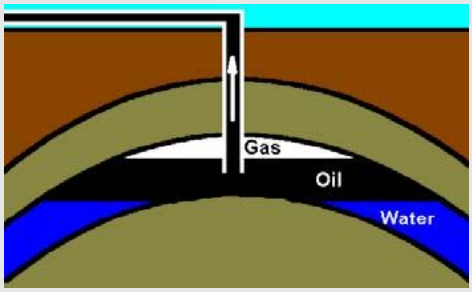
A trap = is a geological situation (lithology) that concentrates petroleum into one place.

A tap is responsible for making a petroleum reserve economic to extract.

- **A stratigraphic trap** is one that results from the arrangement of sedimentary rocks and includes unconformities and those formed due to lithology (rock type).
- **A structural trap**, however, results from the rock deformation and includes anticlines, synclines, faults and salt domes.

All traps require the presence of a **porous and permeable reservoir rock** overlain by an **impermeable cap rock**. Fluids will settle under gravity to form **horizontal layers**, **regardless of rock inclinations**. It is very important to show this when drawing diagrams. The order of densities results in the order of fluid layering. **Gas is the least dense** so will sit at the top within pore spaces of the reservoir, **followed by oil and finally water** at the very bottom.

While you may assume that oil is denser considering the molecules are made of long chained hydrocarbons with higher molecular masses. It is due to the bonding within water compared to in petroleum. The molecules making up petroleum can't come into close enough contact to pack together as efficiently as in water. There are very weak intermolecular bonds in oil and even less so in gas compared to water which has much stronger hydrogen bonds between water molecules.



TRAP-TYPE 1: ANTICLINE

Anticline traps form due to the **deformation of rock strata** into an **arch shape** (antiformal shape).
There MUST always be a cap rock overlaying the reservoir rock as with any trap.

The oil and gas will be **concentrated at the top** of the reservoir rock at the **crest** of the anticline. Once filled to maximum capacity, petroleum will **leak out laterally, at spill points**, and migrate into adjacent rocks.

The storage capacity of an anticline trap is determined by its **size and inter-limb angle**. **Open folds** are going to **store larger amounts** than tight folds. Moreover, the larger the fold, the larger the capacity.

Fold type	Inter-limb angle / Degrees
Gentle	180 – 120
Open	120 – 70
Closed	70 – 30
Tight	<30

A gentle fold may allow for too much lateral leakage, particularly if it is small.

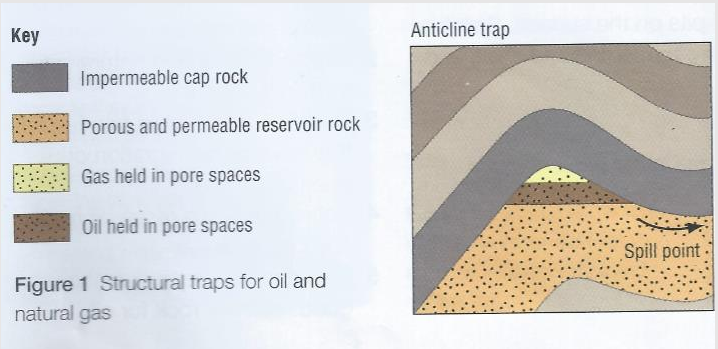
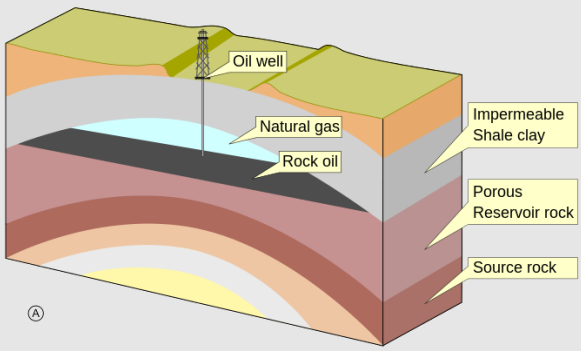


Figure 1 Structural traps for oil and natural gas

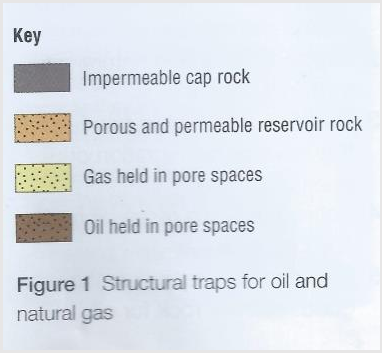


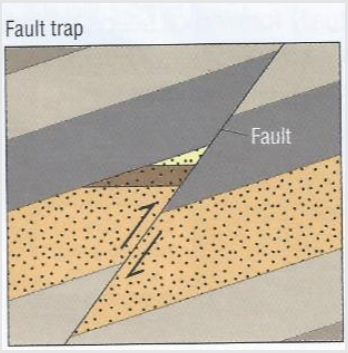
TRAP-TYPE 2: FAULT TRAP

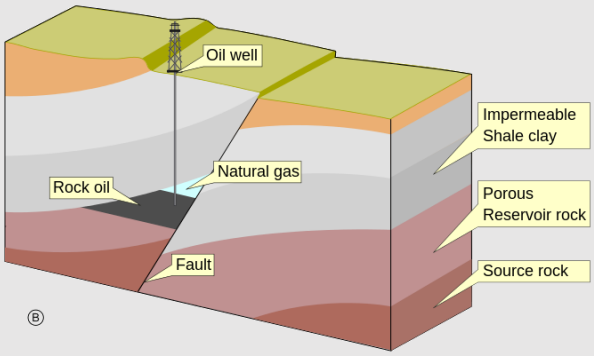
Fault traps occur when there **is movement along a fault plane**, bringing a reservoir rock into a position adjacent to an impermeable rock.

There must also be an impermeable cap rock overlaying the reservoir rock. The **impermeable rock on the opposite side of the fault** prevents the oil and natural gas leaking laterally.

Provided the **strata are dipping**, the oil and natural gas will **migrate up dip**, and settle at the top of the reservoir rock (being trapped at the top adjacent to the impermeable rock). The fault itself must be sealed to prevent oil and natural gas **escaping up the fault**.







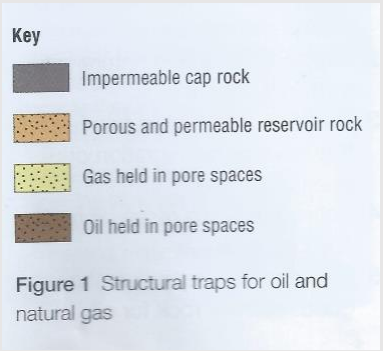
TRAP-TYPE 3: SALT DOME

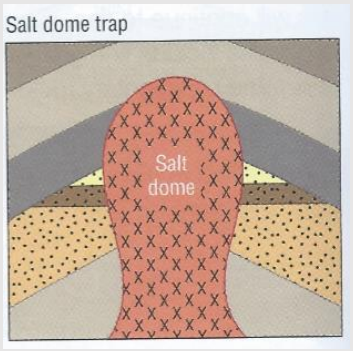
Salt dome traps result from the **presence of evaporates** such as halite and gypsum. Evaporates are less dense **(2.3 g/cm^3)** than surrounding rock (**2.5g/cm^3 to 2.7 g/cm^3**) so form **diapirs** that **rise up** toward the surface. This is just like magmatic diapirs. The rising diapir **uplifts and pierces** surrounding rock, **gently folding** overlying rock strata into anticlines.

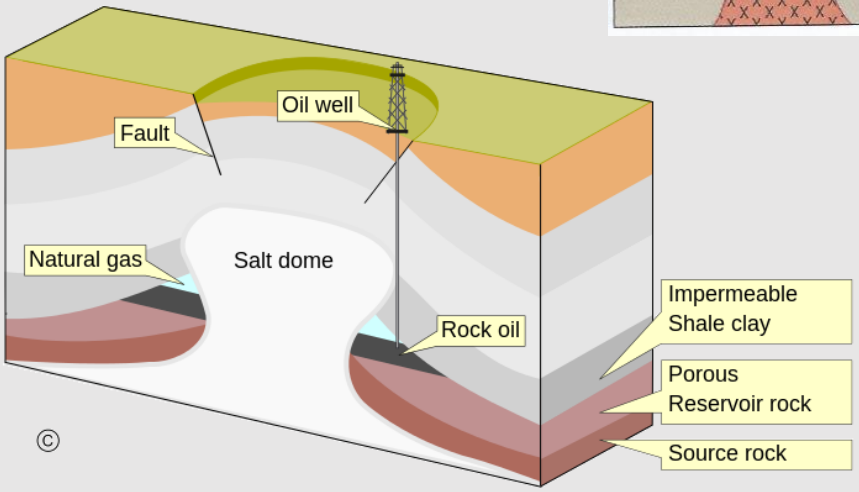
Typical width: 1 – 10 Km **Typical height**: Up to 6 Km

Petroleum can either accumulate **adjacent to the salt dome** (in dipping reservoir rocks) or **in an anticline trap** situated above the salt dome.

There must always be an impermeable cap rock above the reservoir though.







TRAP-TYPE 4: UNCONFORMITY

Unconformity traps will occur when reservoir rocks are part of an **angular unconformity** with **impermeable cap** rocks being deposited horizontally, overlaying the plane of unconformity.

Oil and natural gas **migrate up dip** and become **trapped** at the unconformity due to the impermeable overlaying rock.

The reservoir rock below the unconformity plane must also have **impermeable rocks adjacent** on each side. This prevents **lateral leakage** and helps concentrate petroleum for economic extraction.

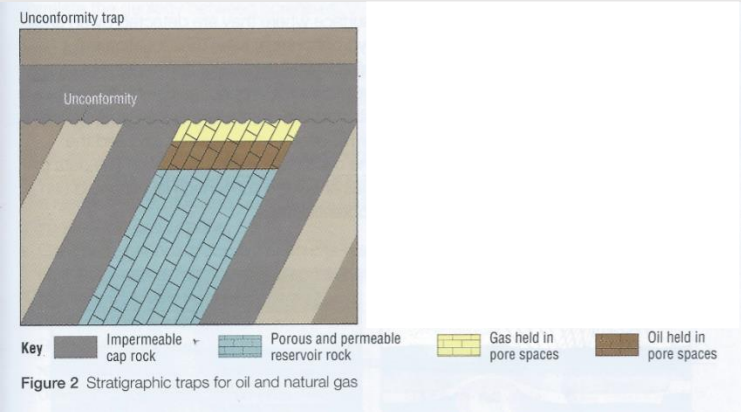
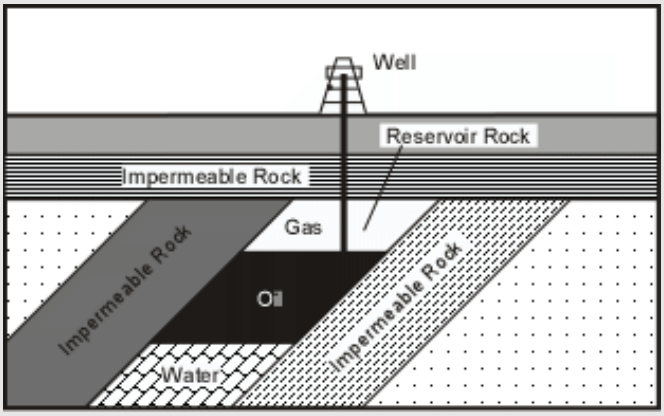


Figure 2 Stratigraphic traps for oil and natural gas

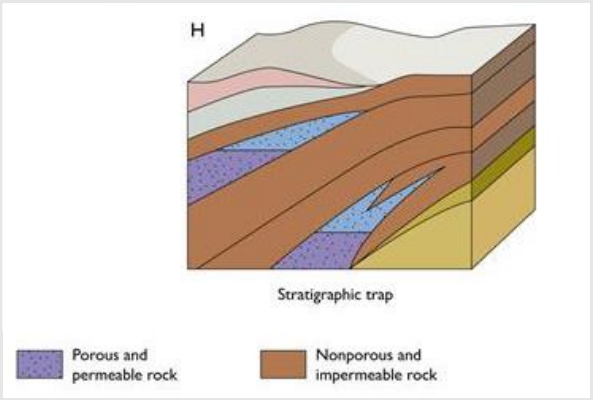


TRAP-TYPE 5: LITHOLOGICAL

Lithological traps occur due to **variation in rock types**.

Fossilised limestone reefs make excellent traps if **surrounded by impermeable** rocks; limestone reefs are made of **highly porous** rock and form in environments where **life thrives** to produce lots of organic matter needed to form petroleum.

Sandstones that formed as **river channel, point bar or deltaic deposits** often have a **lens shape**, making **small but common traps.** The **river or delta clays** surrounding them make **good impermeable cap rocks.**



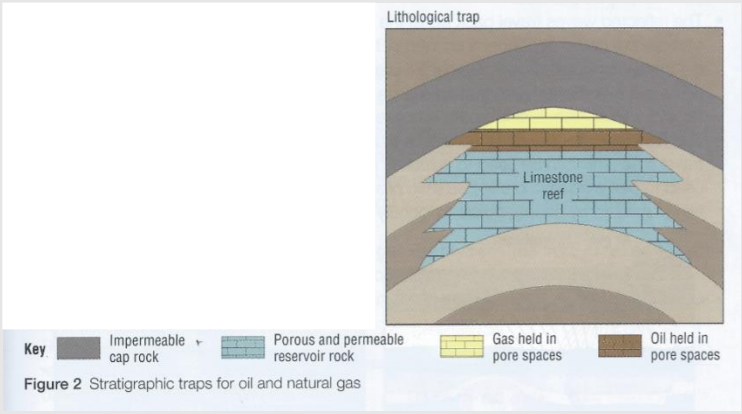


Figure 2 Stratigraphic traps for oil and natural gas

HOW CAN PETROLEUM BE LOST OR DESTROYED ☹

<u>Oil and natural gas may be destroyed in temperatures exceeding 200^{0}C. This occurs if there is:</u>

1. Heat from **igneous or volcanic** activity
2. **Regional metamorphism** where temperatures are high
3. **Burial metamorphism** due to the increasing **thermal gradient**

<u>Oil and natural gas may lost if:</u>

1. **Erosion and removal** of the overlying cap rock
2. **Escaping upward** (migration) along an **unsealed fault**