Natural Drive mechanisms of the reservoir

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Natural Drive Mechanisms

- Pressure on the fluids in a reservoir rock causes the fluids to flow through the pores into the well. This energy that produces the gas, oil, and water is called the *reservoir drive* or *reservoir energy* and comes from fluid expansion, rock expansion, and/or gravity. The type of reservoir drive controls the production characteristics of that reservoir.

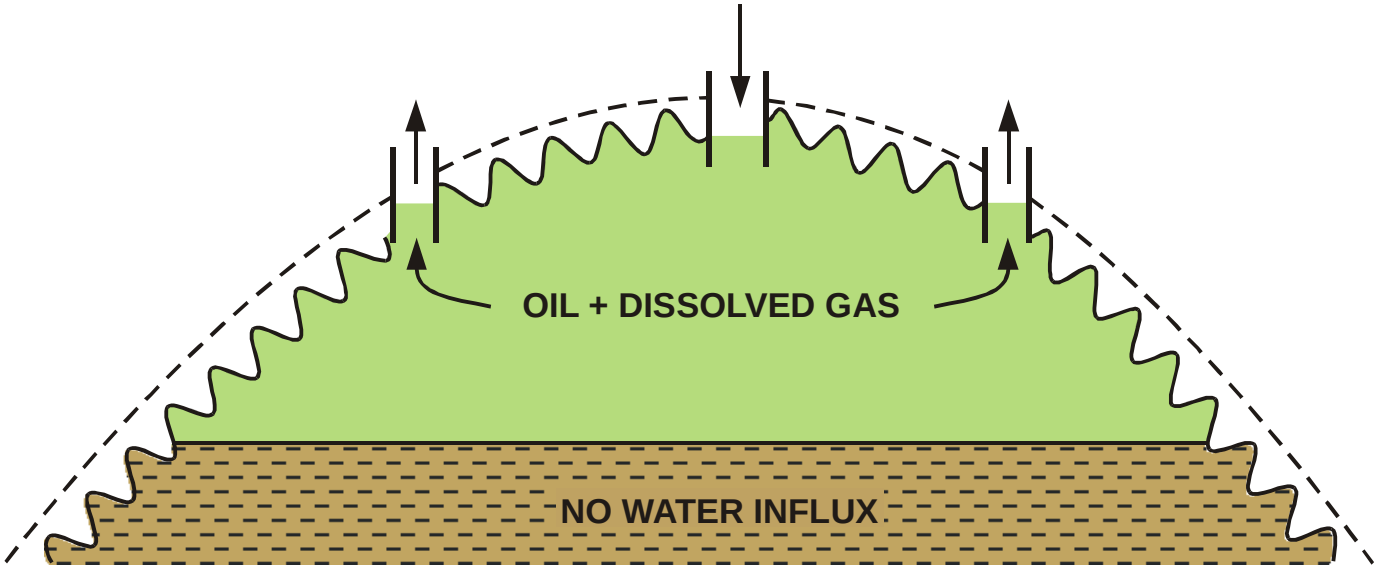
  Oil reservoir has at least one and sometimes two of these reservoir drives.

  Gas reservoirs have only one of two types of reservoir drives.

Natural drive mechanisms

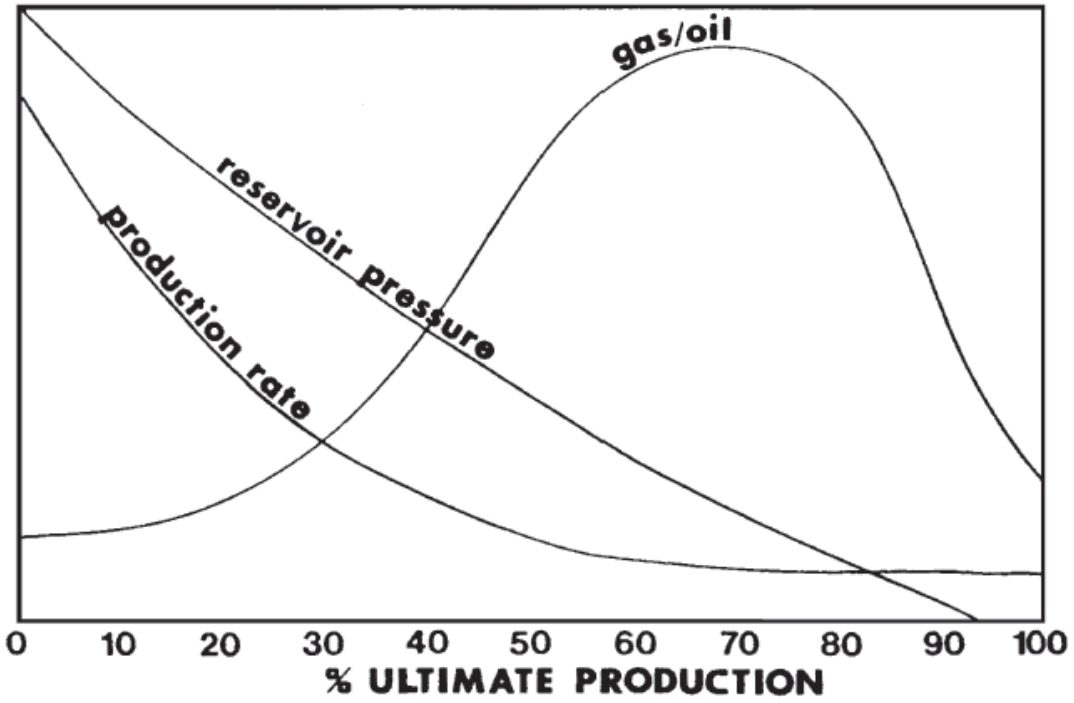
Dissolved gas
Free gascap
Water Drives
Mixed-drive

Dissolved Gas Drive
(solution gas, or depletion drive)



-This reservoir has no gas cap.
-The oil is driven by gas dissolved in the oil.
-When a well is drilled into the reservoir and production is initiated, the pressure on the oil in the reservoir decreases, and gas can bubble out of the oil.
-**Expanding gas bubbles in the pores** of the reservoir force the oil through the rock into the well.
-The **expanding volume of oil and rock** (as the pressure drops) also helps the drive.

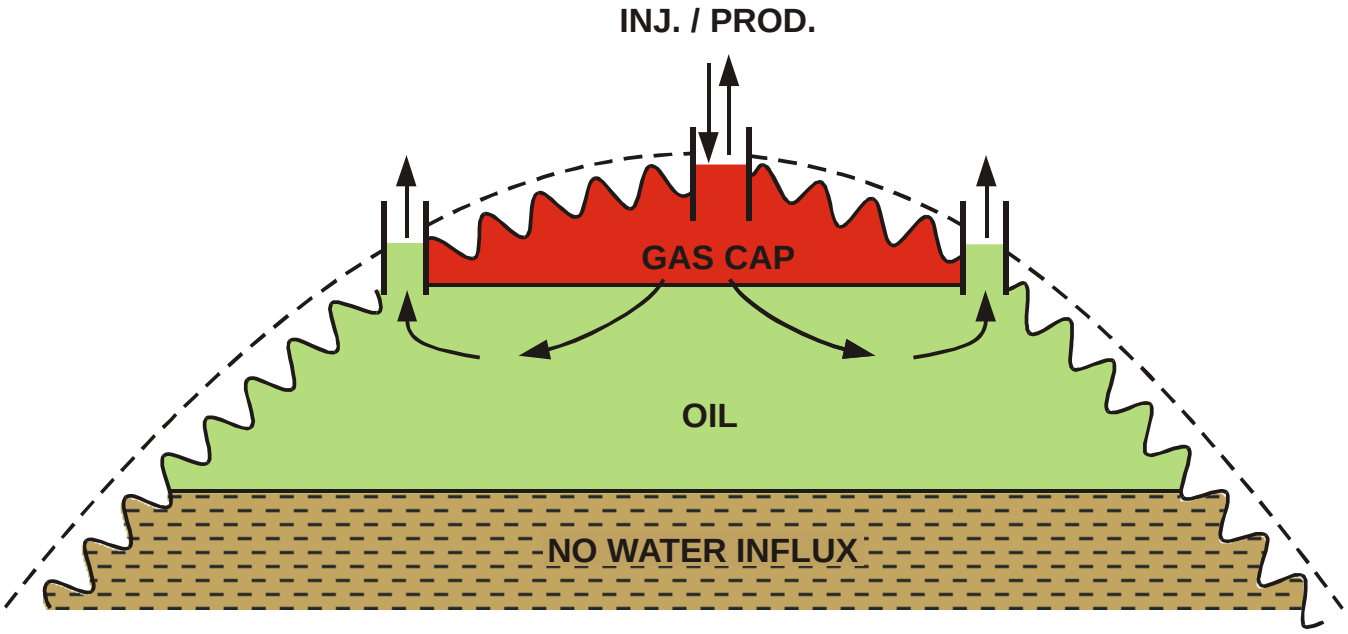
Characteristics of a dissolved-gas drive oil field (very ineffective)



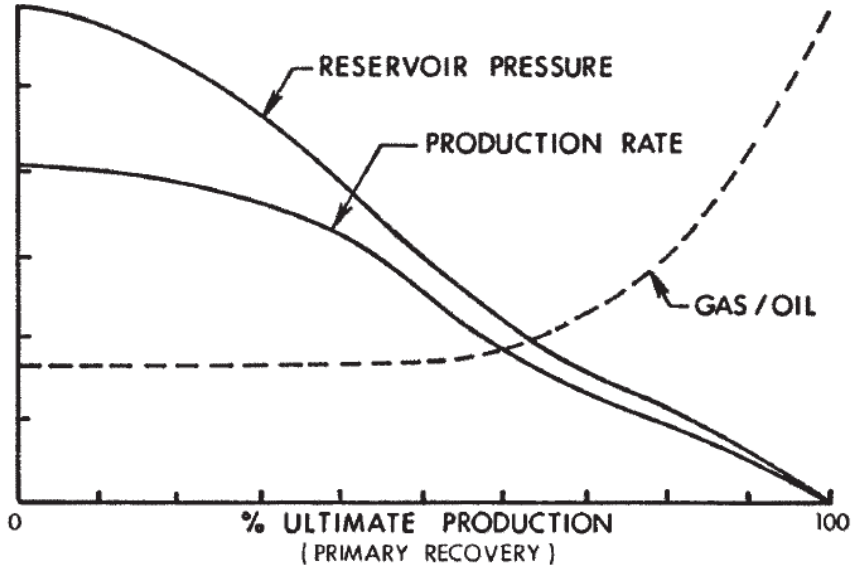
-Very rapid decline in both reservoir pressure and oil production rate
-The wells have to be put on pumps early.
-Little or no water is produced during production
-There is a very rapid gas/oil ratio increase near the end of production.
-Will produce relatively little of the original oil in place **(OOIP)** from the reservoir.
-A *secondary gas cap* located on the subsurface oil reservoir can be formed by gas bubbling out of the oil.

Free gas cap expansion

- The expanding free gas cap pushes the oil into the well.
- Solution gas bubbling out of the oil adds additional energy.



Characteristics of a free gas cap expansion drive oil field (moderate recovery)



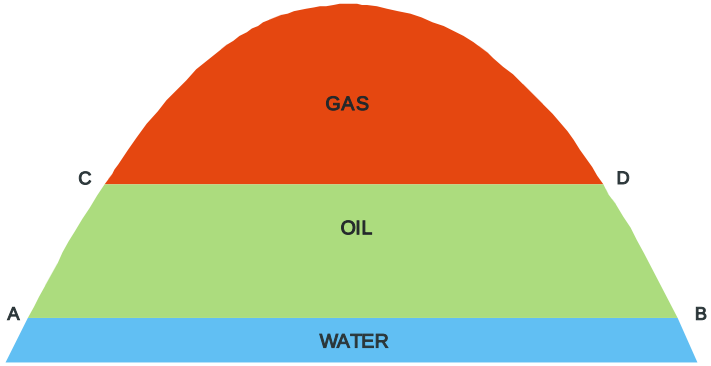
-Has a moderate decline in both reservoir fluid **pressure** and **production rate** as the oil is produced

-A sharp **rise in the gas/oil ratio** as the oil is produced from a well, and the expanding gas cap has reached the well,

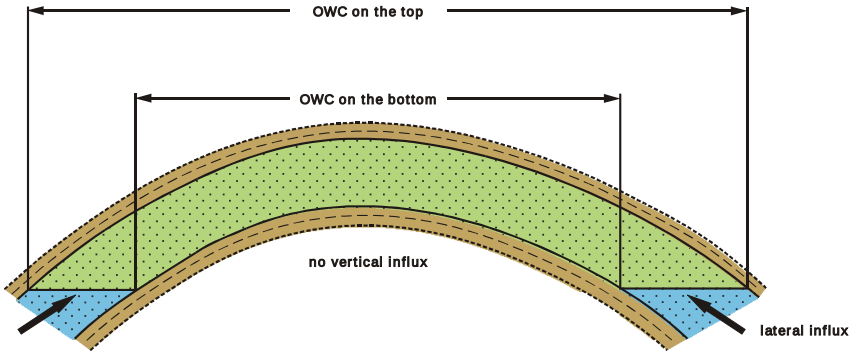
- Further oil production will be very limited from that well.
- Is best developed with wells producing only from the oil portion of the reservoir, leaving the gas in the free gas cap to supply the energy.
- Little or no water is produced.

Water drive

- Are driven by the expansion of water below (bottom water drive), or adjacent to reservoir (edge water drive).
- The produced oil is replaced by water.

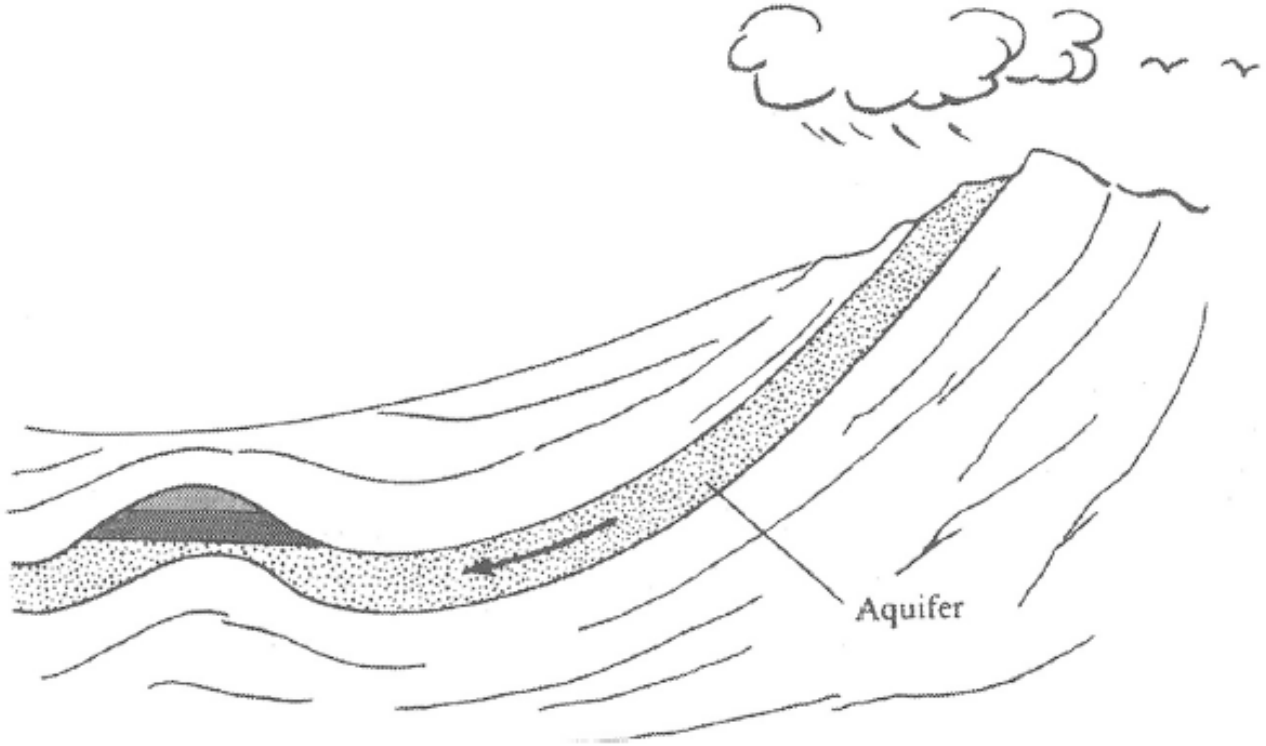


Bottom Water Drive Reservoir



Marginal/Edge Water Drive

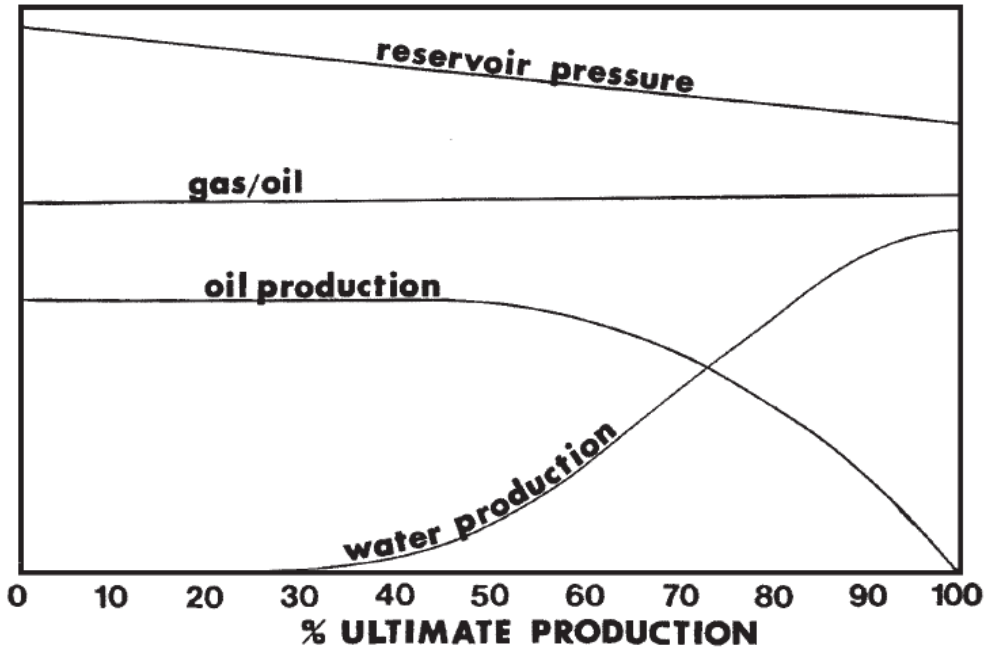
Water drive mechanism



A typical geological setting for a water drive mechanism.
As the field is produced, petroleum is displaced by water from the aquifer.

Selley and Sonnenberg

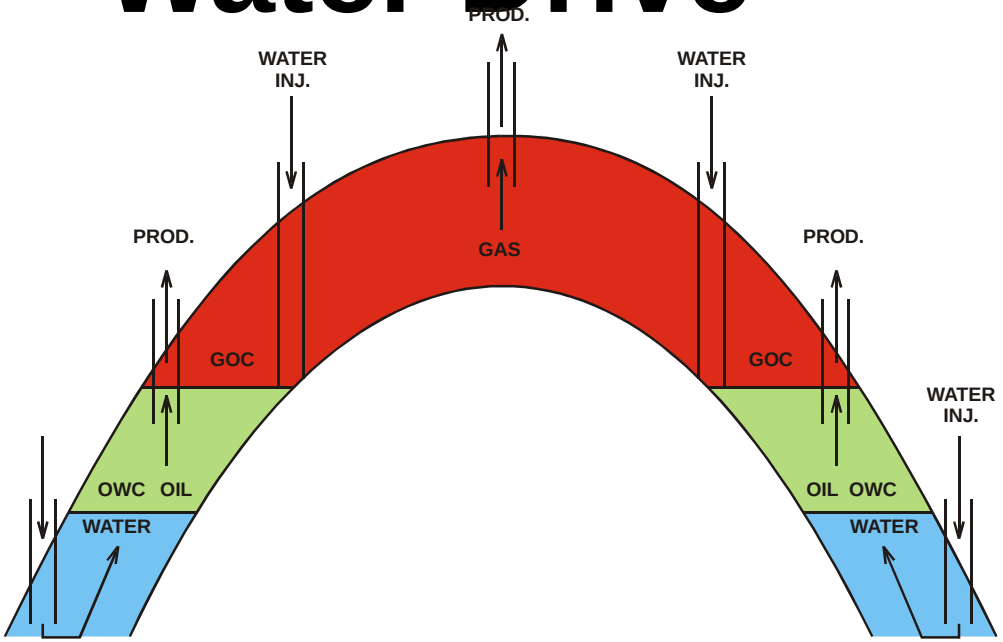
Characteristics of a water drive oil field (recovery is relatively high)



-Maintains an almost constant reservoir pressure and oil production through the life of the wells

-The amount of water produced from a well sharply increases when the water from the supply reaches the well and the well ***goes to water*****.**

Combined Gas Cap and Water Drive



The **most efficient** reservoir drive system is a combination of free gas and water drives :

sweeping the oil from above and below into the wells.

Gravity drive (production is low)

- Gravity is also a drive mechanism. As a secondary drive mechanism it is present in all reservoirs, as the weight of the oil column causes oil to flow down into the well
- It is most effective in **thick reservoirs with high vertical permeabilities or thin reservoirs with steep dips.**
- The rate of oil gravity drainage in the reservoir is usually low compared to field production rates. **Over time, however, gravity drainage can be extremely efficient** and recoveries higher than any of the primary drive mechanisms are possible.
- Is common in old fields that have depleted their original reservoir drive.

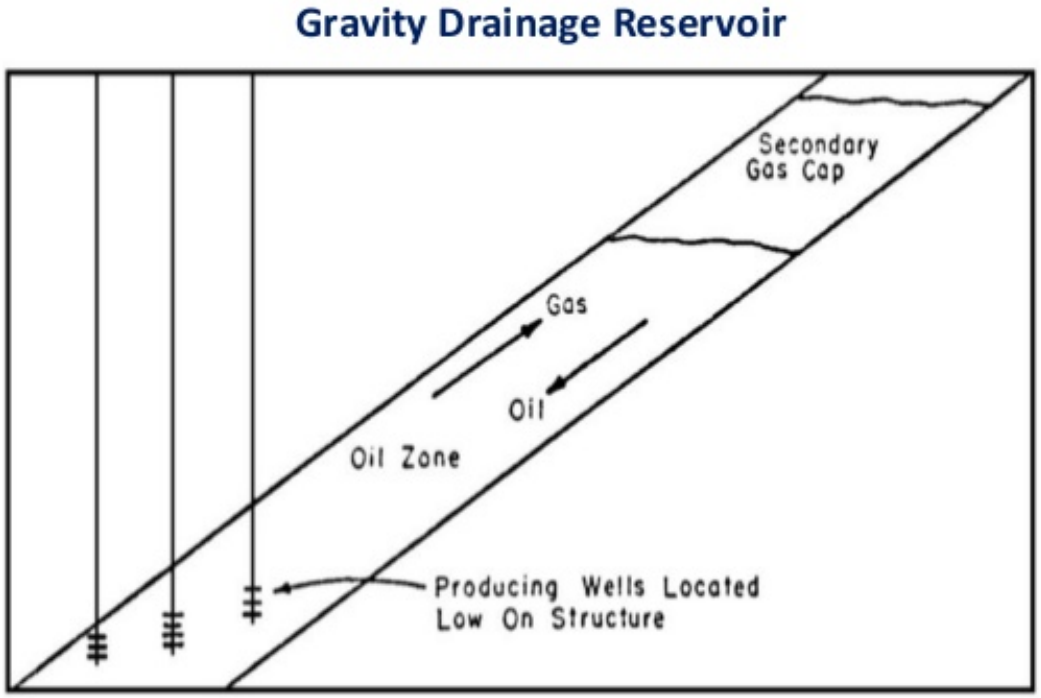


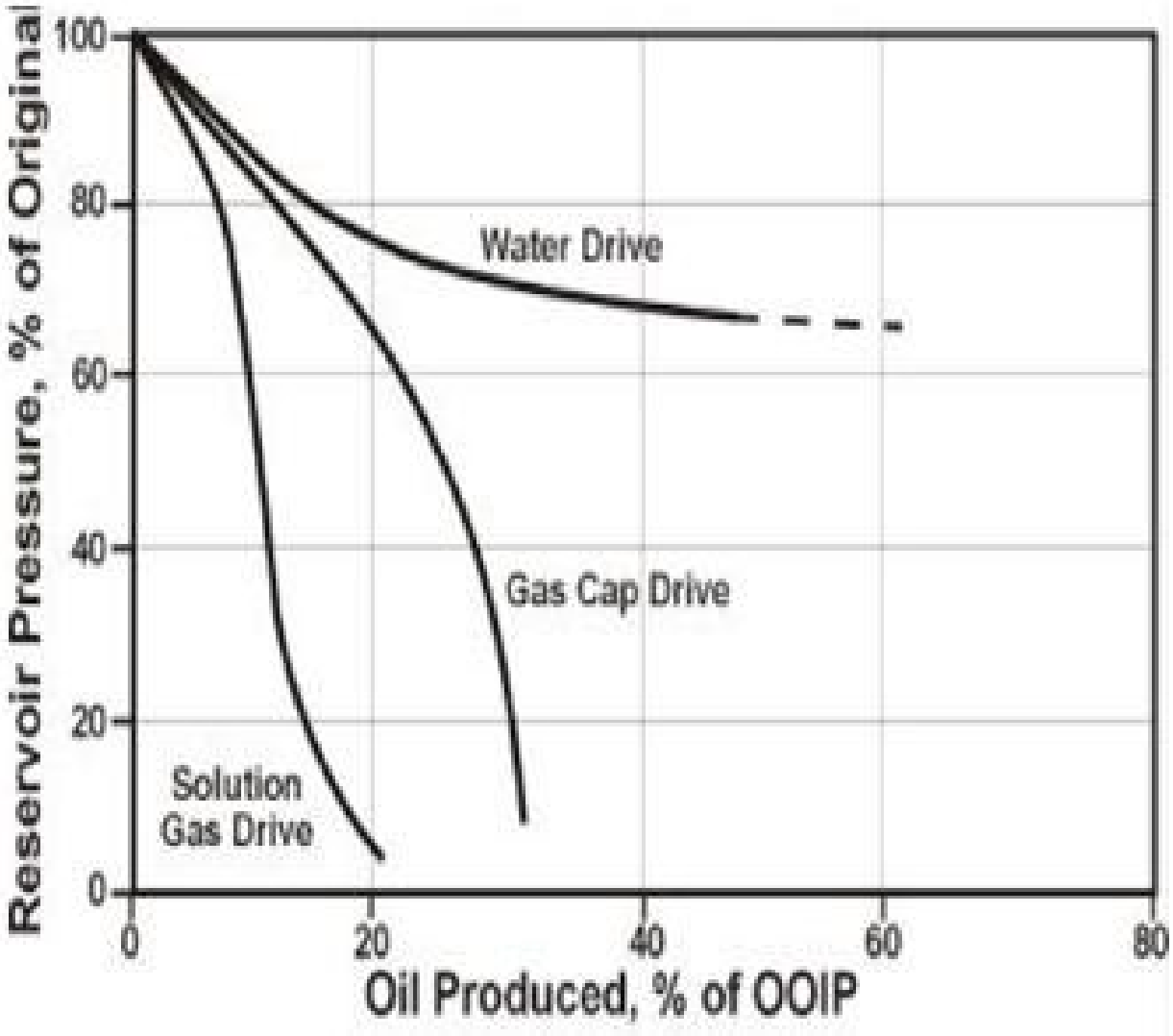
Figure 11-12. Gravity-drainage reservoir. (*After Cole, F.*, Reservoir Engineering Manual, *Gulf Publishing Company, 1969.*)

Well placement

- In order to take maximum advantage of the gravity-draininge-mechamism wells should be structurally as low as possible. This will result in maximum conservation of the reservoir gas.

- In a solution gas drive reservoir perforated down dip**, gravity drainage can cause released solution gas to migrate upward and oil to flow downward, conserving reservoir energy** and increasing recovery to near that of a water drive.

Oil production in reservoirs with different drive mechanism



Gas reservoir drives

- Have either an expansion-gas or a water drive.
- ***1. Expansion-gas*** is due to the pressure on the gas in the reservoir. When a well is drilled into the high-pressure reservoir, the well has relatively low pressure. The high-pressure gas in the pores of the reservoir expands out into the well. This drive recovers a relatively large amount of original gas in place in the reservoir.
- **2. A *water-drive*** gas reservoir is similar to a water-drive oil reservoir and is due to expanding water adjacent to or below the reservoir. It is not as effective as an expansion-gas drive because the water flows around and traps pockets of gas in the reservoir. It has a moderate recovery of gas in place.