

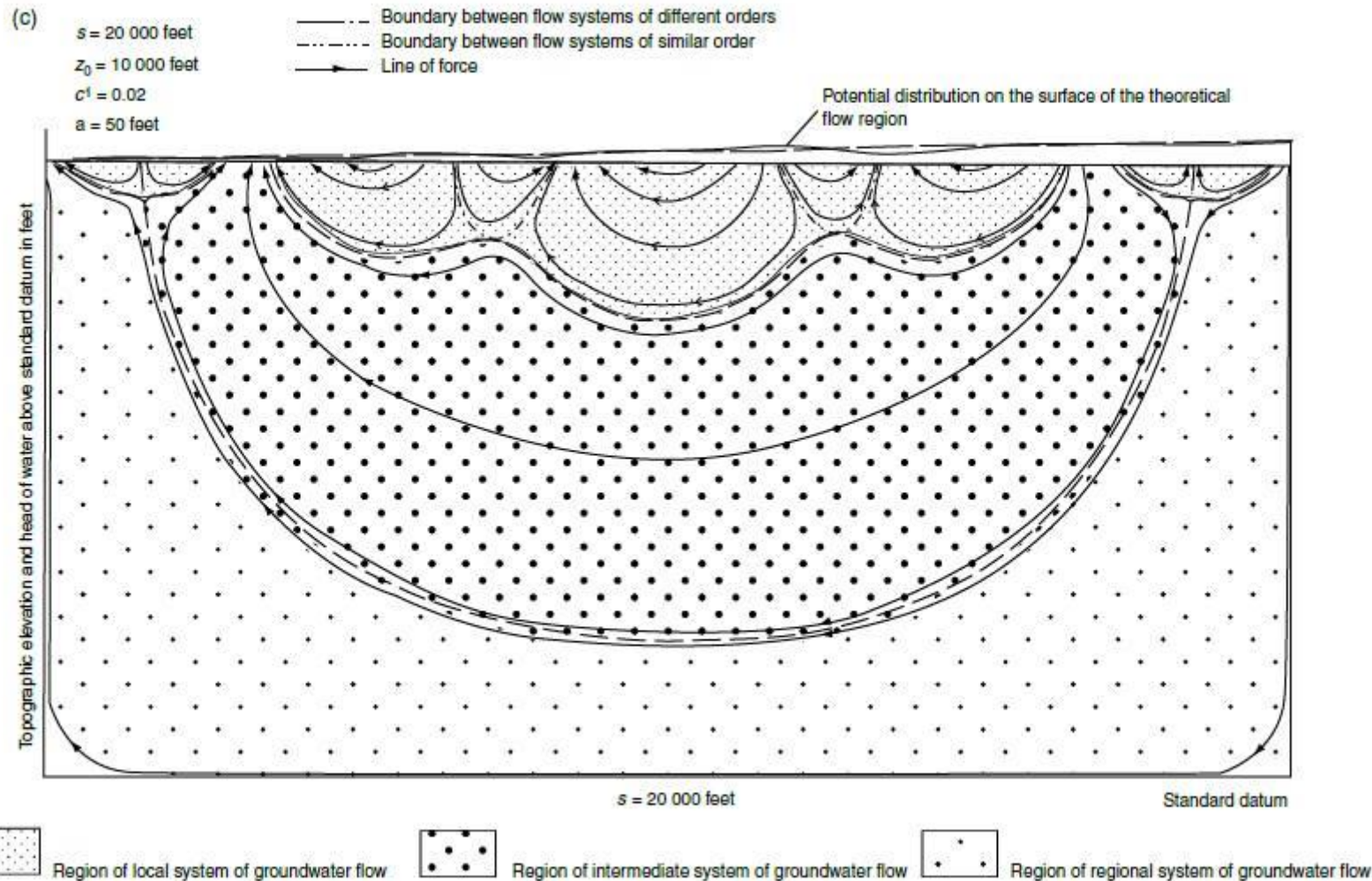
Application of the regional groundwater flow theory to hydrocarbon exploration based on the hydraulic theory and surface geochemical techniques of petroleum accumulation

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43rd IAH Congress
Student Competition on Regional Groundwater Flow



- Regional Groundwater flow: driven by gravity



- Hydraulic Theory of Petroleum Migration:

- Regional Groundwater Flow is a transport agent of matter and energy
- Formation waters move in distributed system (discharge, midline and recharge regions)

- Part 1: Regional Groundwater Flow responsible for migration and accumulation of petroleum
- Part 2: Role of Regional Groundwater Flow on the deposit of hydrocarbon through the near-surface exploration methods

Part 1: Regional Groundwater Flow responsible for migration and accumulation of petroleum

Forms of petroleum migration

- Oil droplets and gas bubbles
- In a continuous oil and gas phase
- As colloidal or micellar solutions
- As true molecular solutions
- As petroleum in a framework of organic matter
- As soluble organic matter

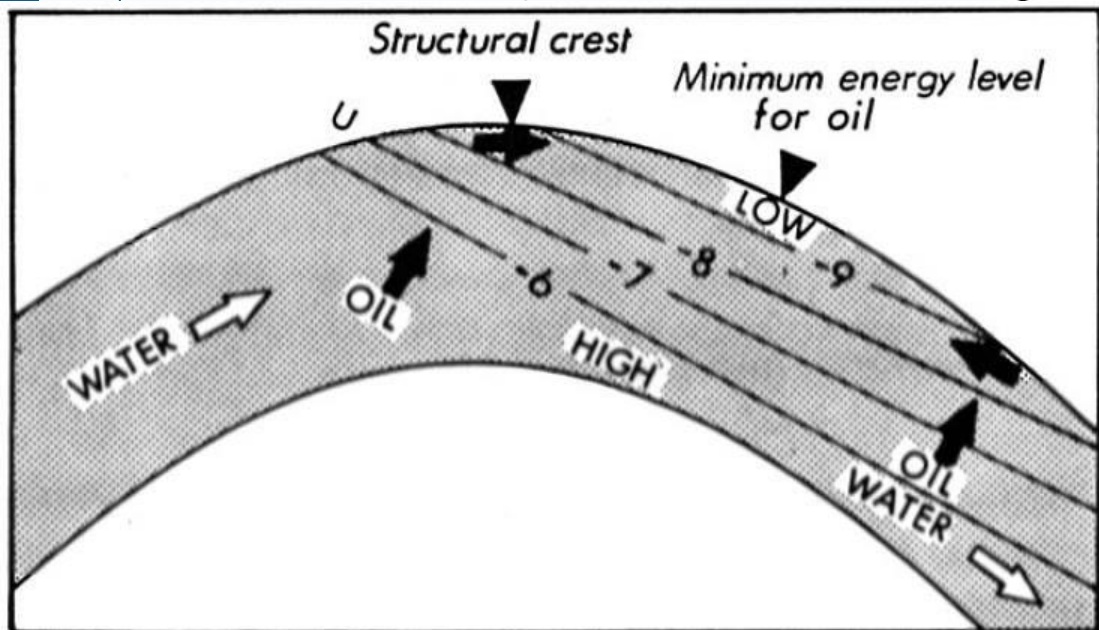
(Tóth, 1988)

Energy sources causing migration

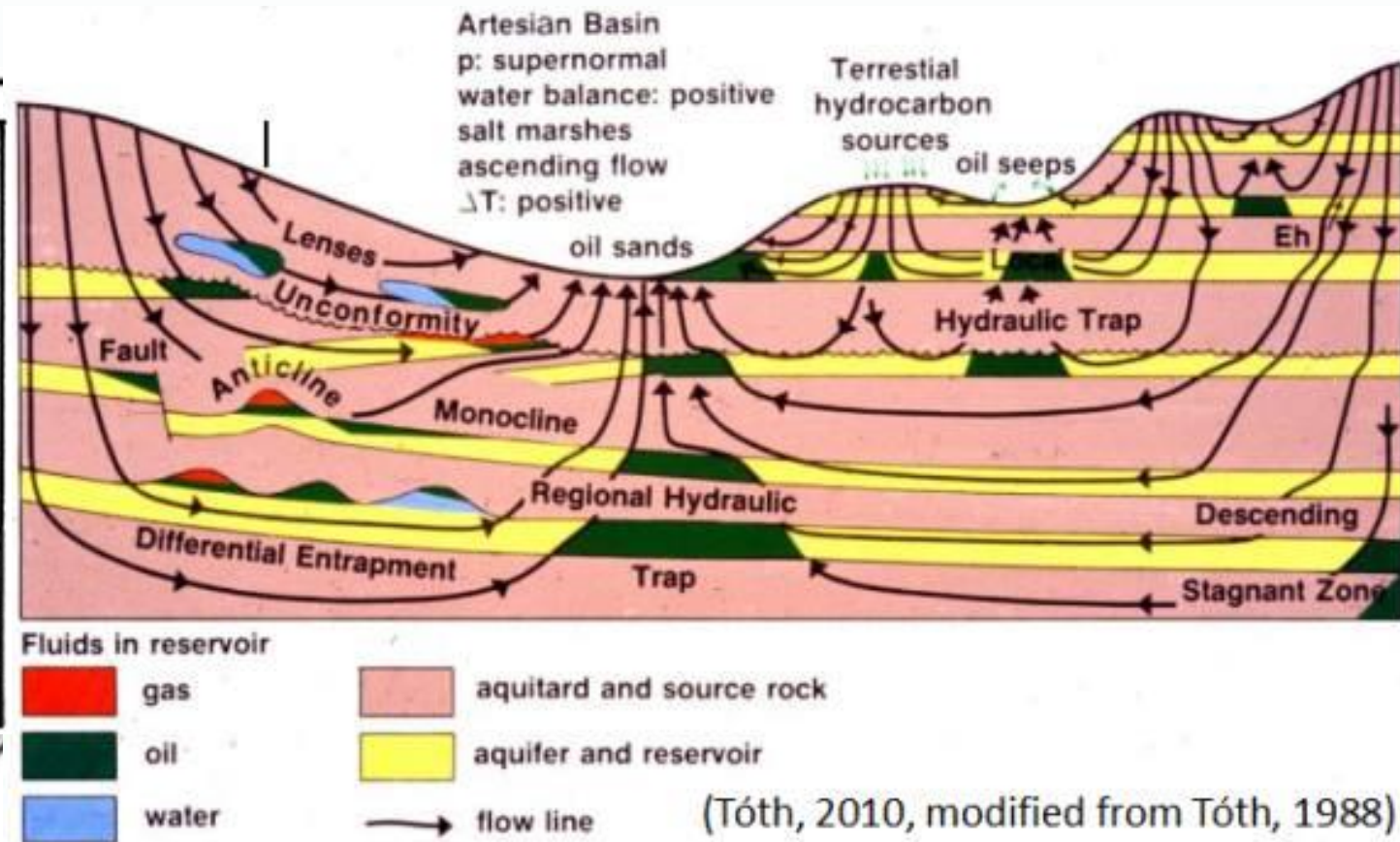
- Compaction and elastic rebound of the rocks
- Buoyancy
- Gravitation in confined carrier bed or aquifers or in regionally unconfined rock frameworks
- Gas expansion
- Thermal expansion of liquids
- Molecular diffusion of hydrocarbon
- Osmosis

(Tóth, 1988)

Conditions of accumulation



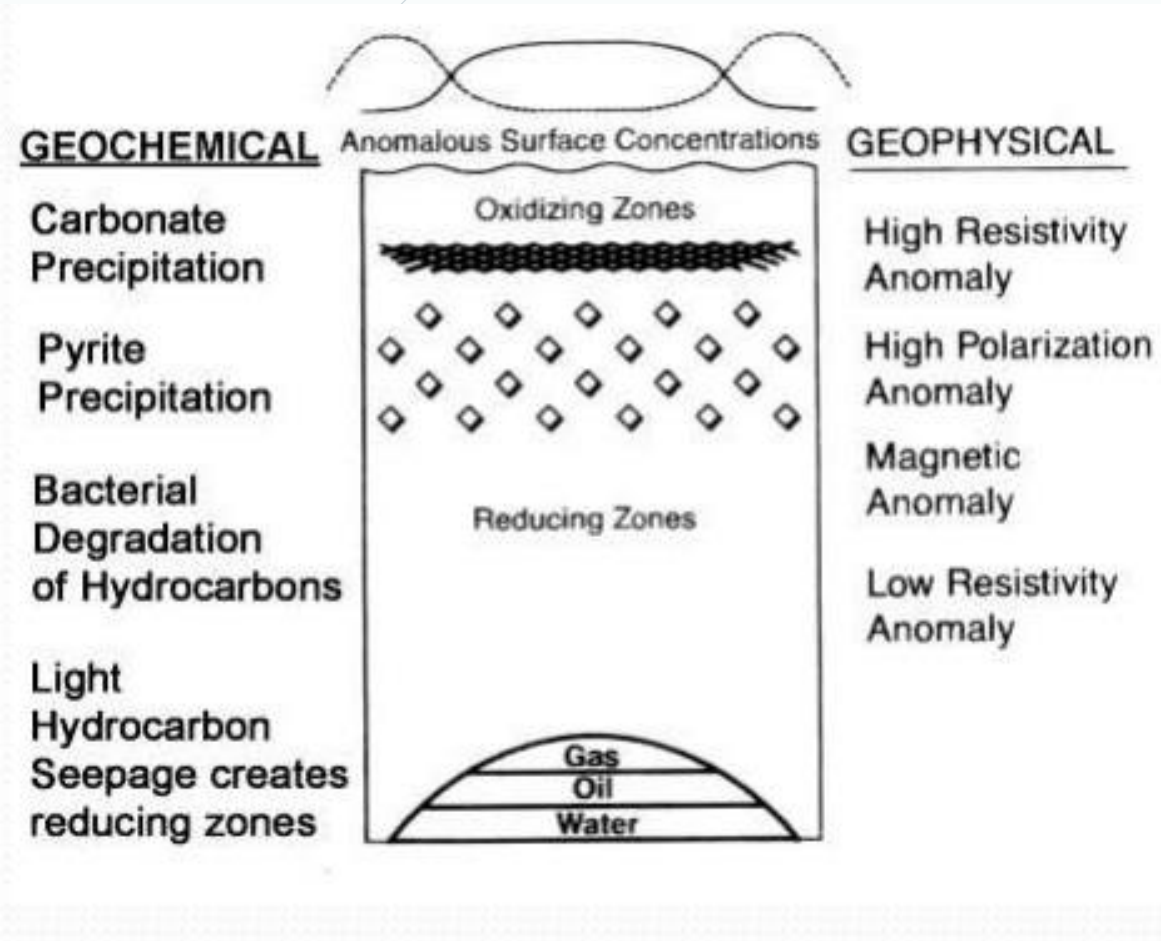
$$h = \frac{p}{\rho g} = z + \frac{p}{\rho g}$$



Part 2: Role of Regional groundwater flow on the deposit of petroleum through near-surface exploration methods

Near-surface hydrocarbon exploration methods

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Observations of anomalies in surface:

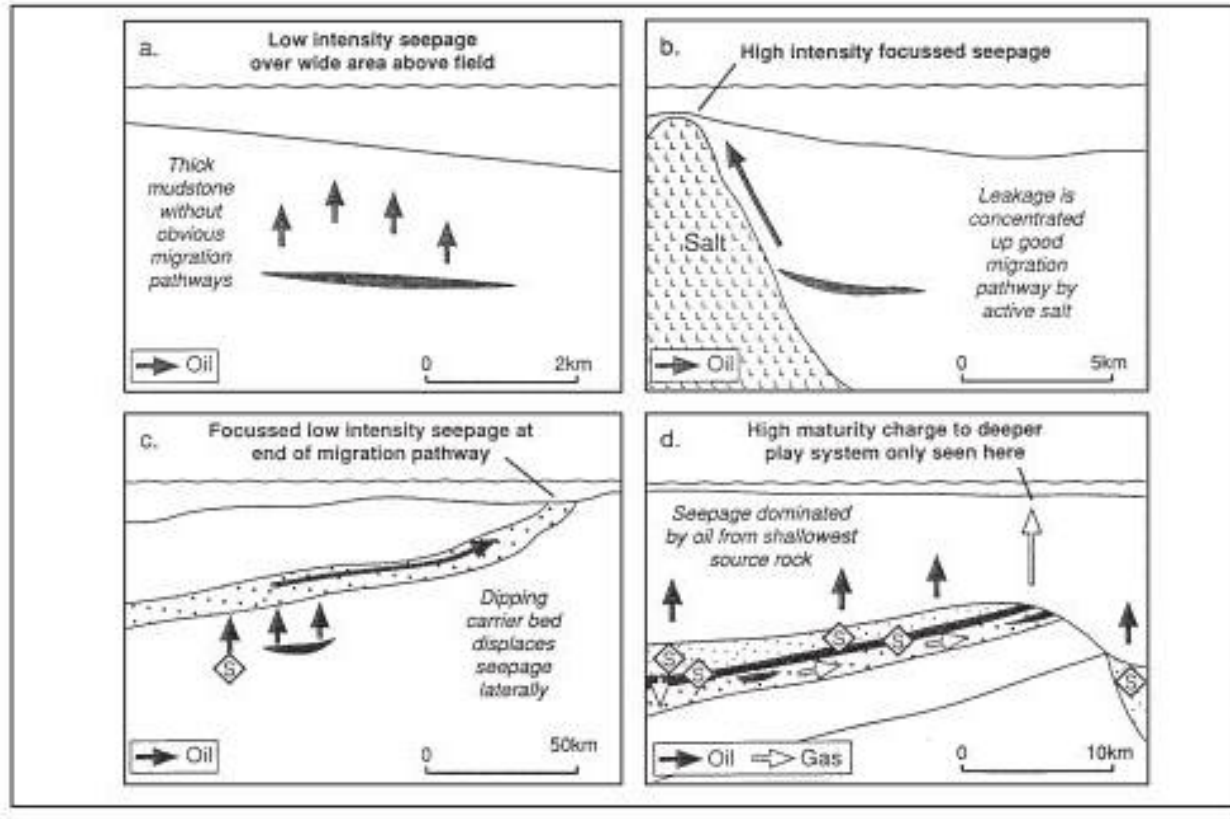
- Macroseepages : clearly visible oil and gas
- Microseepages : geophysical/ geochemical anomalies

Jim Fausnaugh, 2009

Lateral migration of petroleum towards the near-surface

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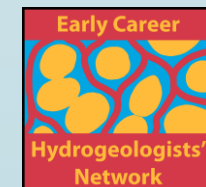
The figure below shows examples of contrasting seepage styles and migration pathways from the Gulf of Mexico and the North Sea.



→ Relationships between surface geochemical anomalies and accumulations of petroleum at depth can be complex: it requires to integrate seepage data with geological, geophysical, and hydrologic data

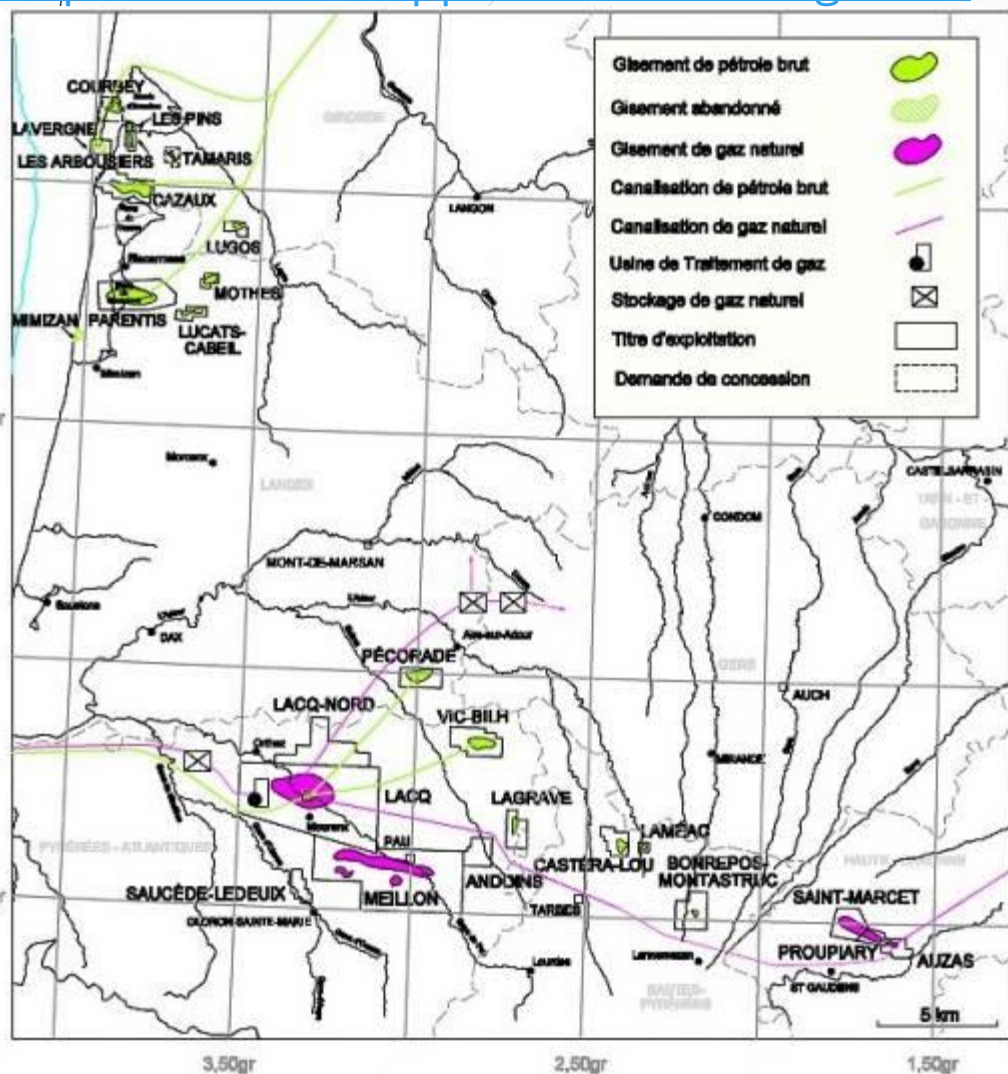
→ Lateral movement is induced by hydrogeology data

Modified from Trasher et al. 1996; courtesy AAPG



Cases of study

<http://www.developpement-durable.gouv.fr>



- Pannonian basin (Hungaria): measured flux of Helium (by applying Toth's model of advective groundwater flow)
- Aquitain basin (France):

Conclusion

- To better understand the migration and accumulation of petroleum, both the geology and groundwater flow should be taken into account for hydrocarbon exploration in order to characterise petroleum behavior (accumulation/migration)
- Near-surface methods can be a good way to localise precisely anomalies at the surface that are related to petroleum accumulation at depth (according to the regional groundwater flow)

References

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Thank you for your attention

