

Mixing oil and water: Reinforcing groundwater concepts through comparisons with petroleum migration

Solution Set

The following are partial lists of similarities and differences between freshwater aquifers and petroleum reservoirs. While not exhaustive, it illustrates the types of observations that students can make and distinctions that students can draw during the brainstorming exercise and subsequent discussion.

Similarities

- both water and oil are fluids
- flow is driven by gravity and pressure (head gradients)
- flow is influenced by porosity and permeability of geologic materials
- both water and oil can contain dissolved gases
- flow occurs in response to natural or engineered gradients
- flow is generally slow and laminar so that Darcy's Law applies
- radial flow occurs in the vicinity of wells
- drawdown can occur in the vicinity of extraction wells
- both aquifers and reservoirs can be confined

Differences

<u>Oil</u>	<u>Water</u>
Higher T, P	Low T, P
More compressible	Less compressible
Multiphase flow – fluids share pores	Single phase flow – saturated zone Multiphase flow – unsaturated zone (Soils usually water wet)
Continuous/discontinuous phases	Continuous phase
Relative permeability = $f(\text{saturation})$	Hydraulic conductivity = $f(k, \text{temperature})$
Upward density-driven flow (buoyancy)	Downward density-driven flow (solutes)
Migration up structural gradient	Flow down head gradient
Timescale: thousands to millions of years	Timescale: decades to thousands of years
Modified Darcy's Law	Darcy's Law
'free surface' (oil-water contact) below	'free surface' (water table) above