Relative Permeability

Applications of relative permeability data:

- to model a particular process, for example, fractional flow, fluid distributions, recovery and predictions

- Determination of the free water surface; i.e., the level of zero capillary pressure or the level below which fluid production is 100% water.

- Determination of residual fluid saturations

Relative Permeability

Definitions

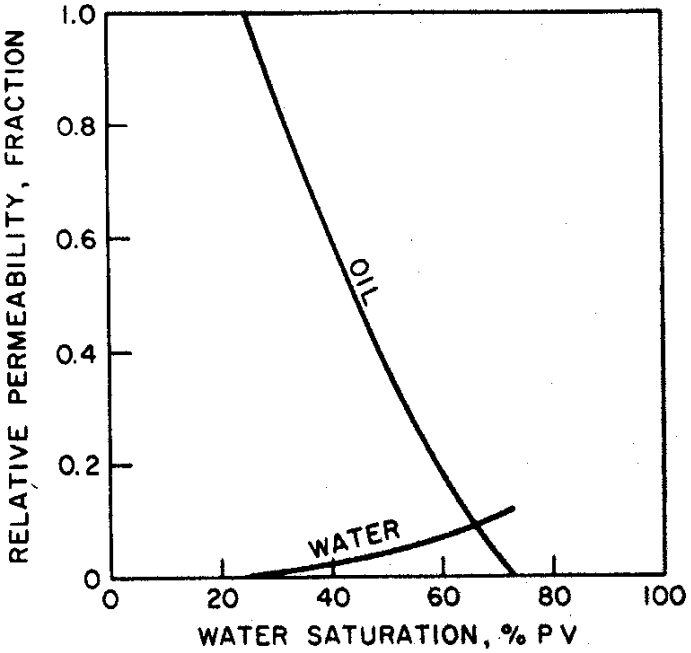
Absolute permeability – ability of the porous media to transmit fluids

Effective permeability – permeability of a given phase when more than one phase is present

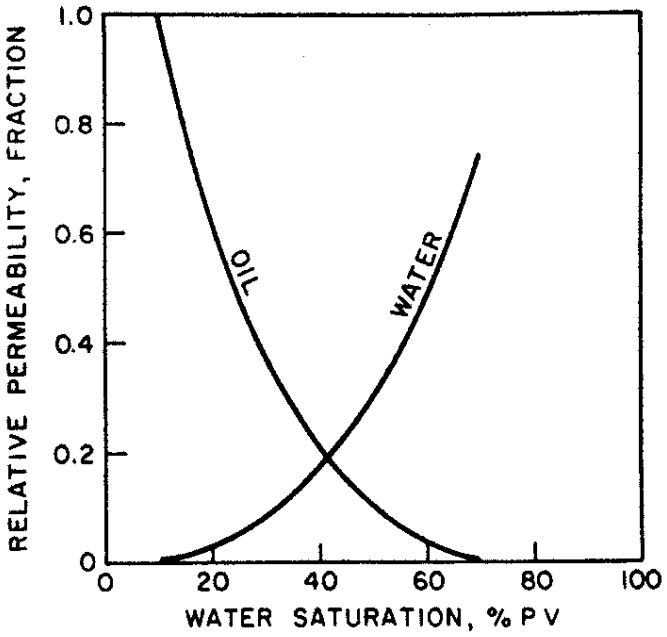
Relative permeability is the ratio of the effective permeability for a particular fluid to a reference or base permeability of the rock.

$$k_r = \frac{k_{eff}}{k_{ref}}$$

Relative Permeability

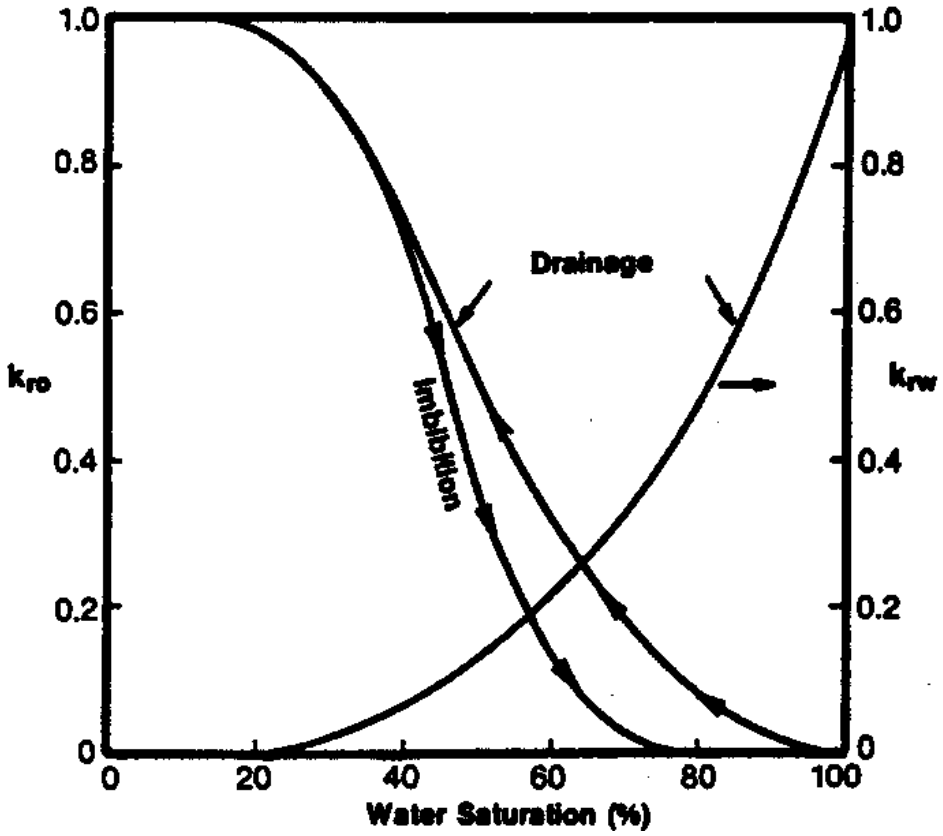


Typical water-wet, oil-water relative permeability curves



Typical oil-wet relative permeability curves

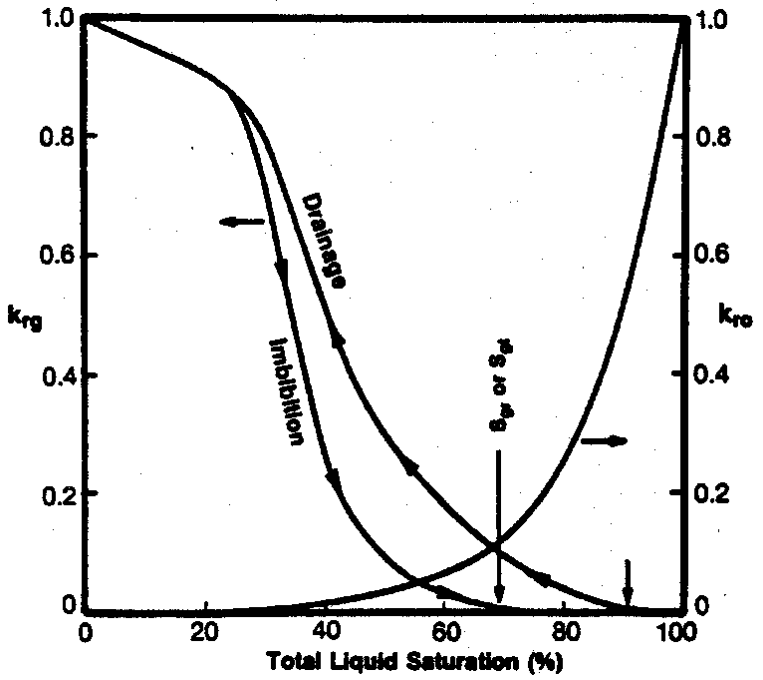
Relative Permeability



Relative permeability hysteresis, imbibition vs. drainage

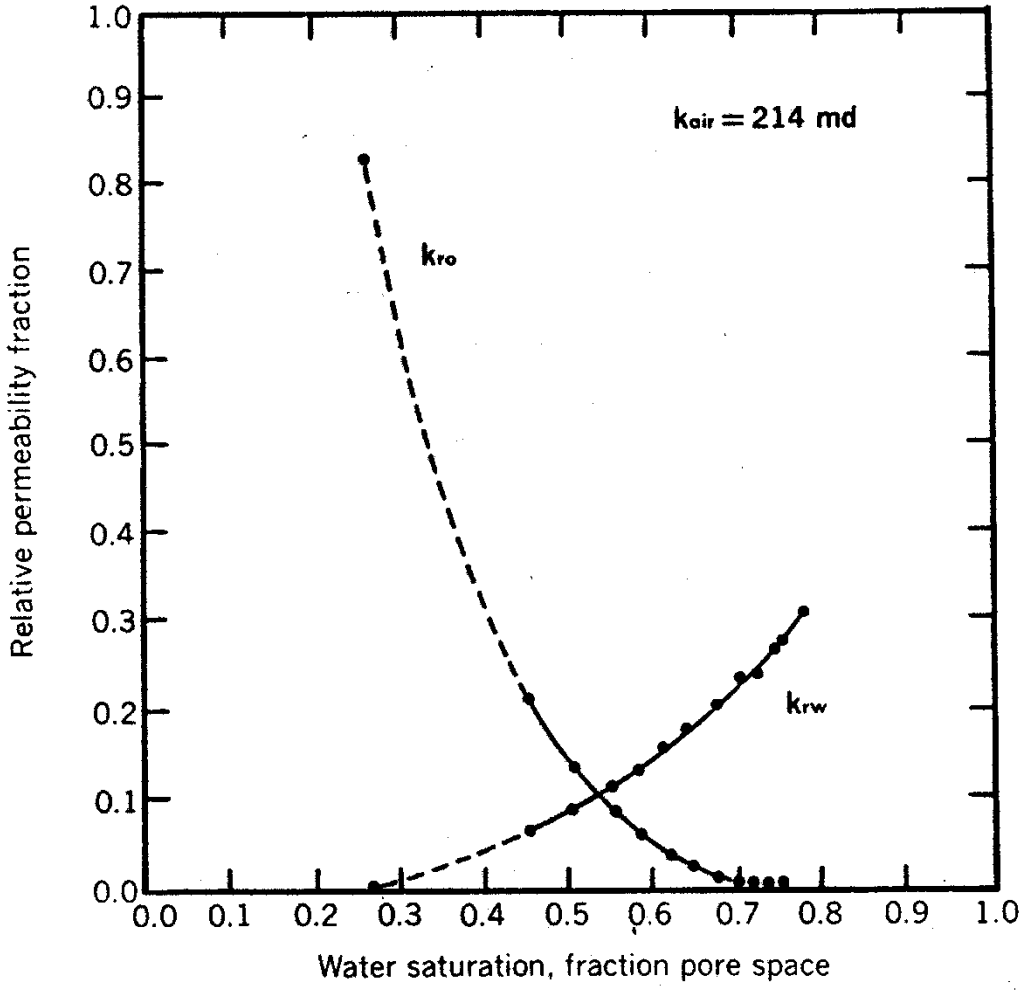
Relative Permeability

- Sgc - critical gas saturation, when gas first becomes mobile, generally at S_g = 2 to 5%, always between 0 and 10% this would be measured during a drainage process
- Sgr = Sgt -residual or trapped gas saturation, when gas can no longer flow because its saturation is being reduced during an imbibition process, generally at values between 15 and 40%.

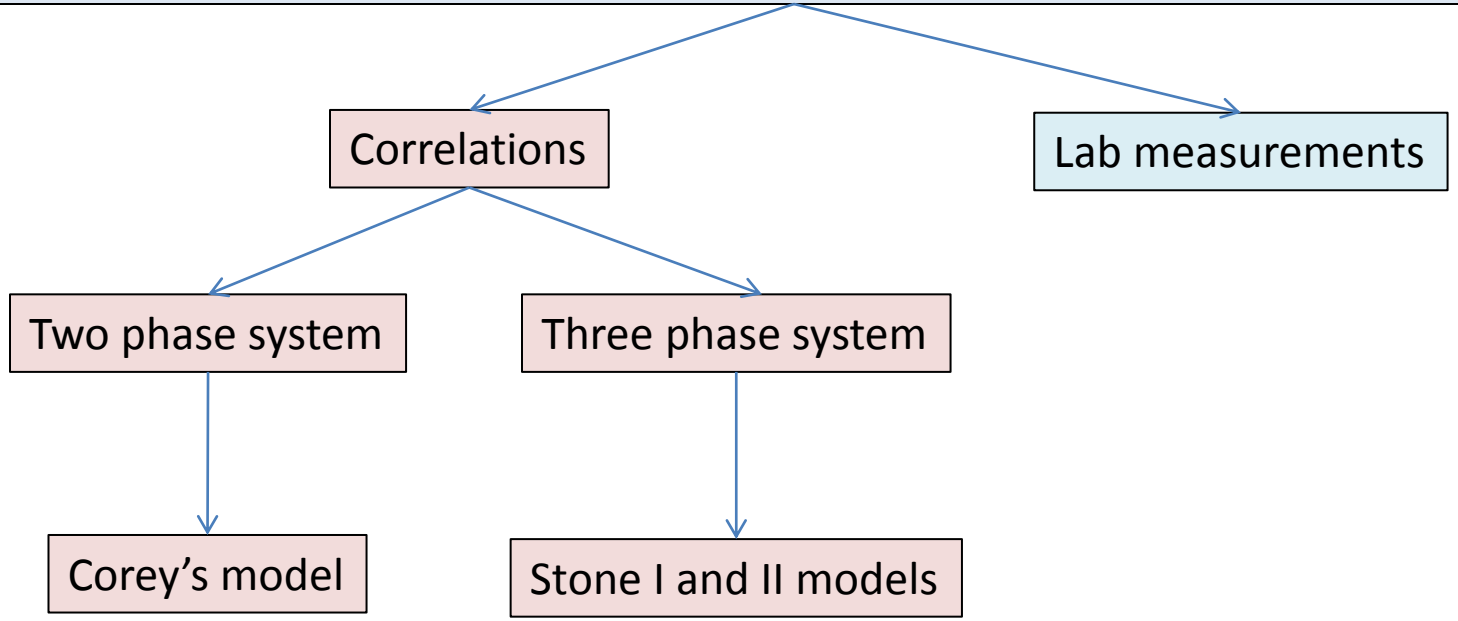


Typical Gas and Oil Relative-Permeability Curves

Relative Permeability Example



Relative Permeability



Stone I

- Scaling technique
- Input two sets of relative perm data
  Krow, krw = f(Sw)
  Krog, krg = f(Sg)
- And Sor for three-phase system
- Find kro = f(Sw,Sg)

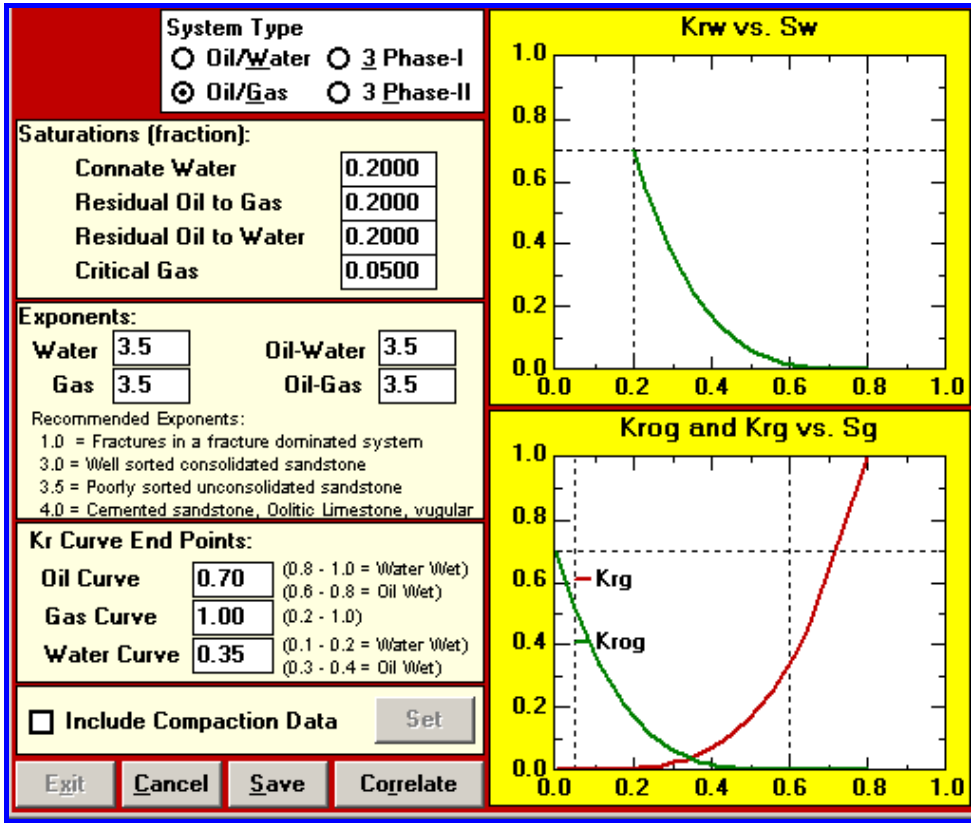
Stone II

- Probabilistic model
- Does not require Sor
- Find kro = f(Sw, Sg)

Relative Permeability

Correlations

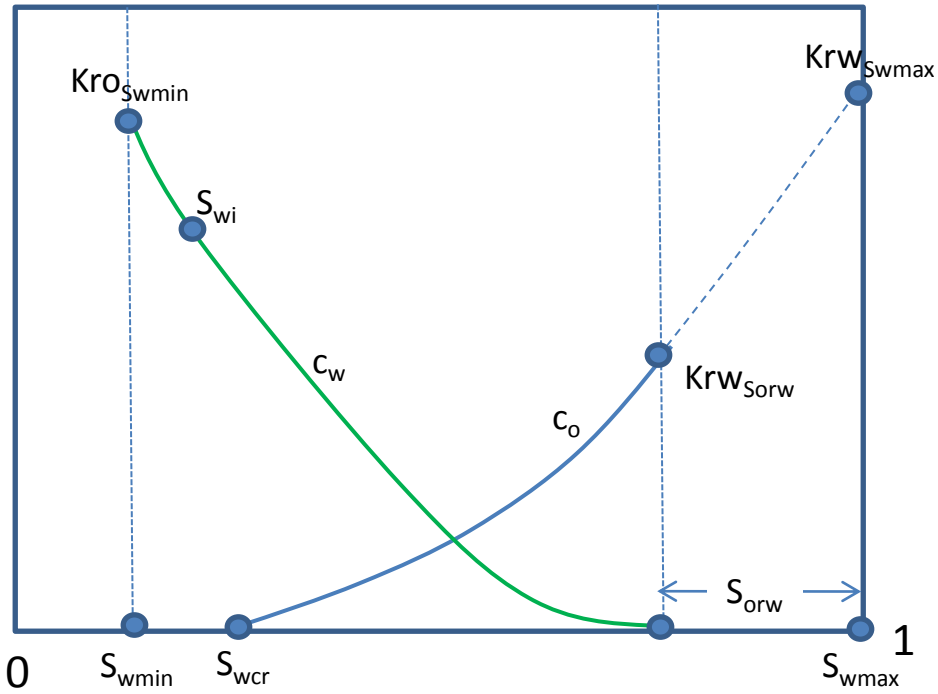
- Select the:
  - wettability and system type for the model
  - endpoint saturations
  - exponents to define the shape of the kr curves
  - endpoint relative permeabilities



Relative Permeability

Corey Correlation (Oil-water)

S_{wmin}	minimum water saturation
S_{wcr}	critical water saturation
S_{wi}	initial water saturation
S_{orw}	residual oil saturation to water
$K_{rw\ (Sorw)}$	water relative perm at residual oil
$K_{rw\ (Swmax)}$	water relative perm at maximum water saturation
$K_{ro(Swmin)}$	oil relative perm at minimum water saturation
C_o	Corey oil exponent
C_w	Corey water exponent

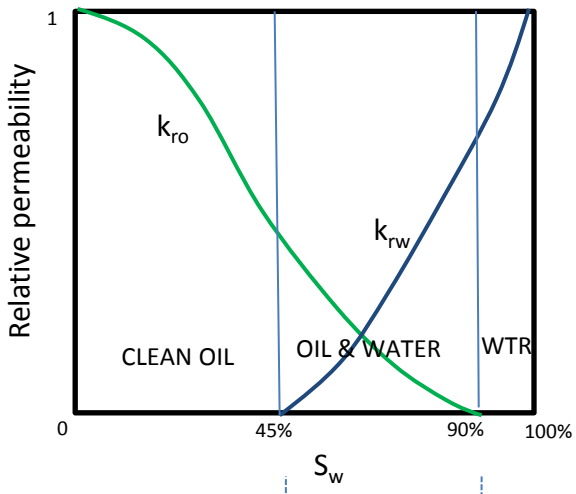


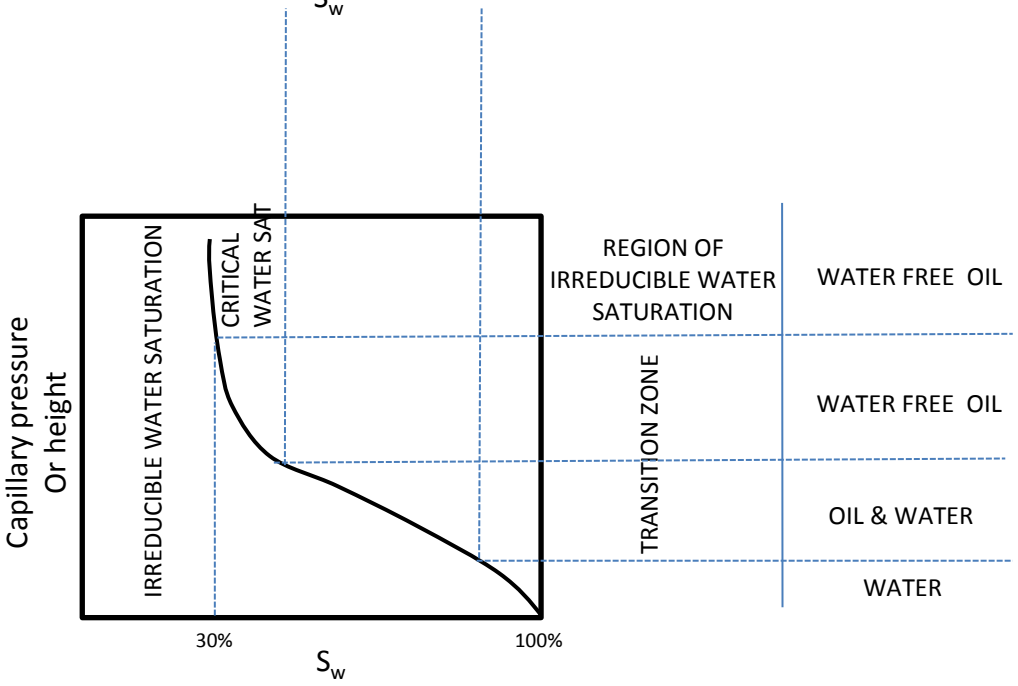
$$k_{ro} = k_{ro(S_{w\,min})}\left[\frac{S_{w\,max} - S_w - S_{orw}}{S_{w\,max} - S_{wi} - S_{orw}}\right]^{C_o}$$

$$k_{rw} = k_{rw(S_{orw})}\left[\frac{S_w - S_{wcr}}{S_{w\,max} - S_{wcr} - S_{orw}}\right]^{C_w}$$

Relative Permeability

Relationship between capillary pressure and relative permeability





Relative Permeability

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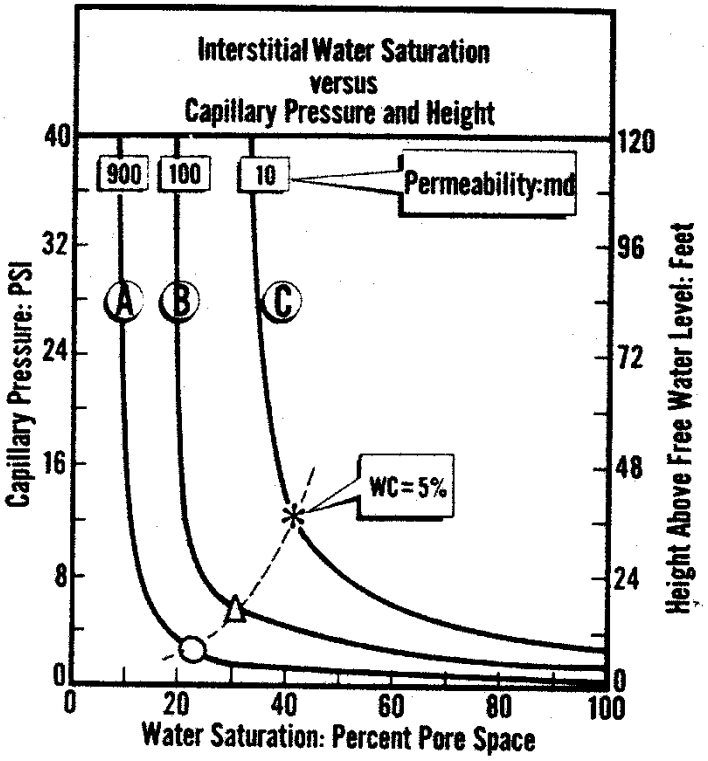

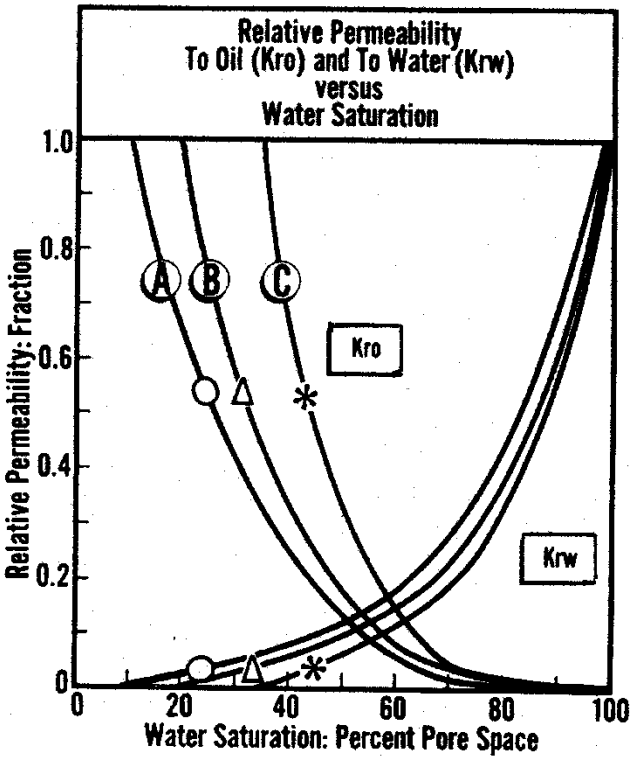

Relative Permeability

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