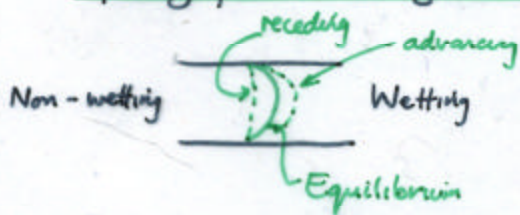


2.4 DRAINAGE AND IMBIBITION

Capillary pressure is hysteretic

\ominus changes with direction of displ.

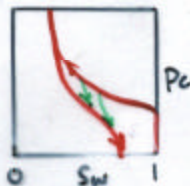


← For two fluids (liquids)

For Fluid-gas



Raindrop



\therefore Not a unique function of S_w , but depends on path.

\therefore conclude that we cannot determine P_c from S_w , alone

Drainage - Saturated with wetting fluid initially - displace with non-wetting

Imbibition - Saturated with non-wetting fluid initially -

place wetting fluid on surface \rightarrow "spontaneous" imbibition to equilibrium condition where capillary forces equal those due to gravity.

Unsaturated flows - Water = wetting; air = non-wetting

S_{NW0} = entrapped air in sample

$S_{NW} \leq S_{NW0}$ the non-wetting fluid is non continuous \therefore does not flow.

Drying and wetting scanning curves are hysteretic.



FIG. 9.2.8. Contact angle (θ) in a capillary tube in a stationary state, in a displacement of a nonwetting liquid by a wetting one (θ_1) and in a displacement of a wetting liquid by a nonwetting one (θ_2).

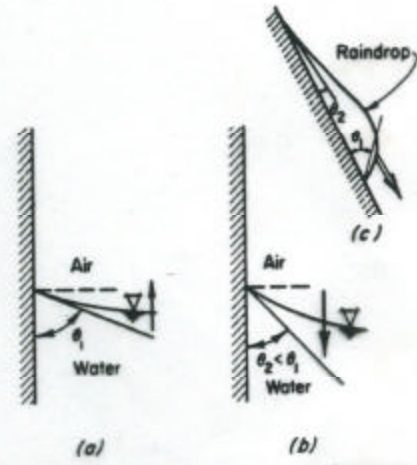


FIG. 9.2.9. Hysteresis in contact angle (rain drop effect).

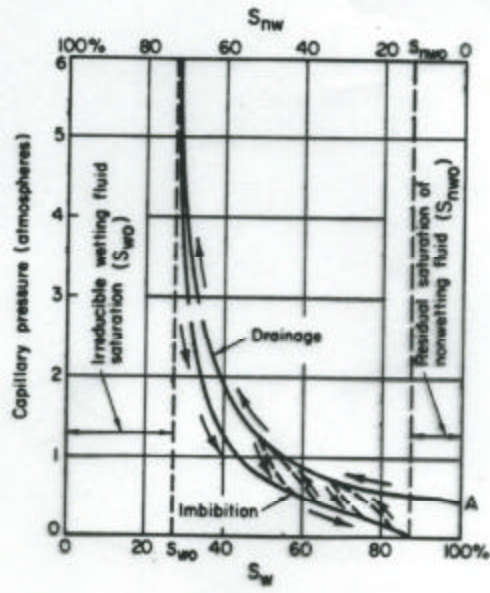


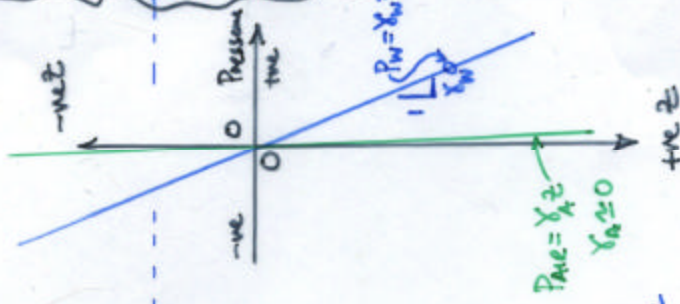
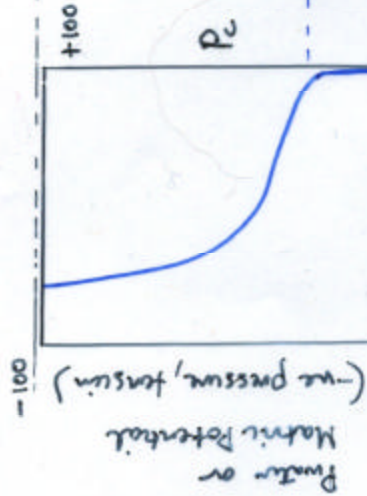
FIG. 9.2.10. Typical capillary pressure—wetting fluid saturation curves illustrating hysteresis.

STATIC SYSTEMS

$P_c = P_{nw} - P_w$

Vadose zone

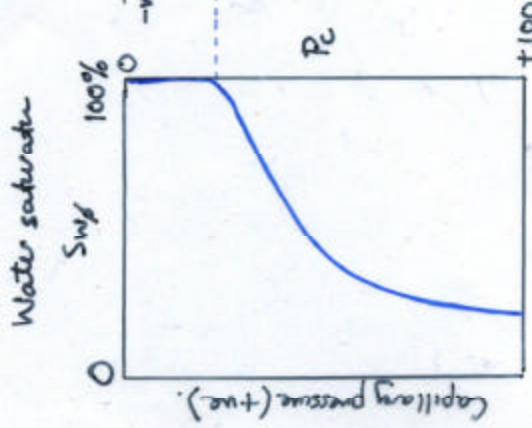
$P_c = P_{air} - P_{water}$



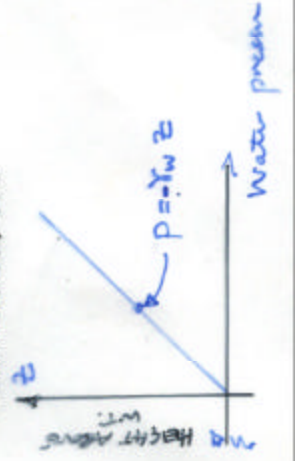
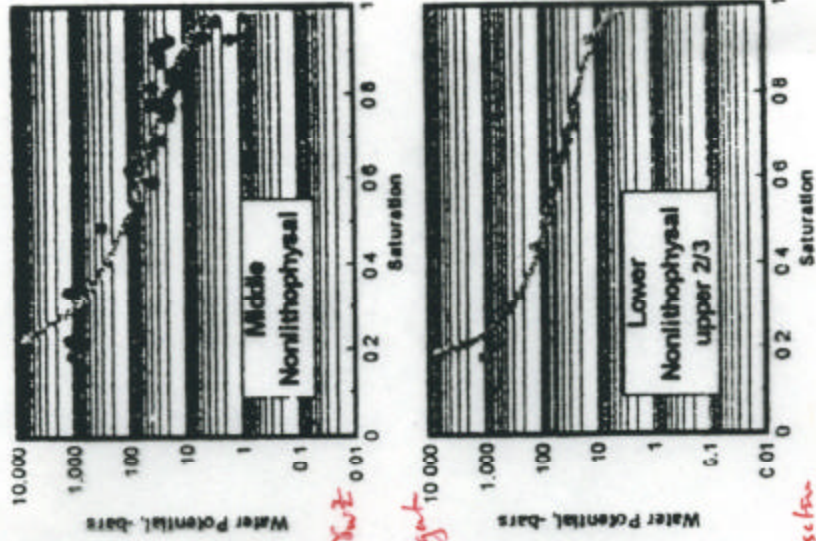
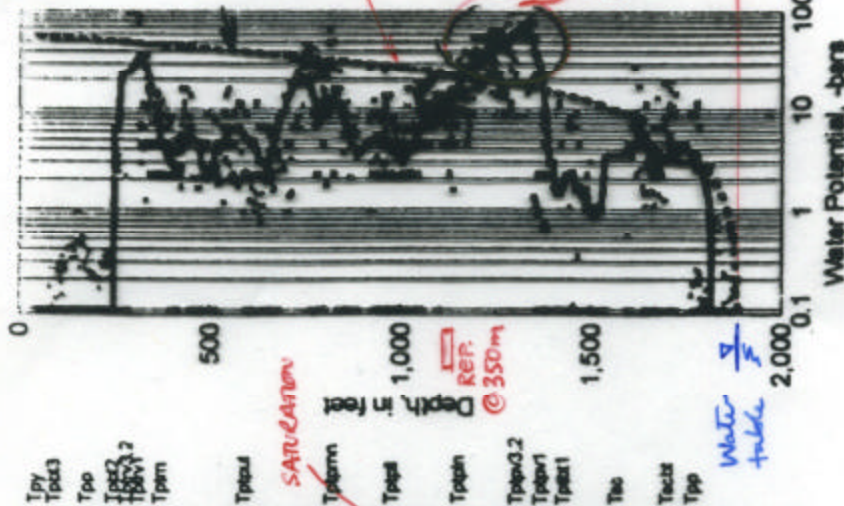
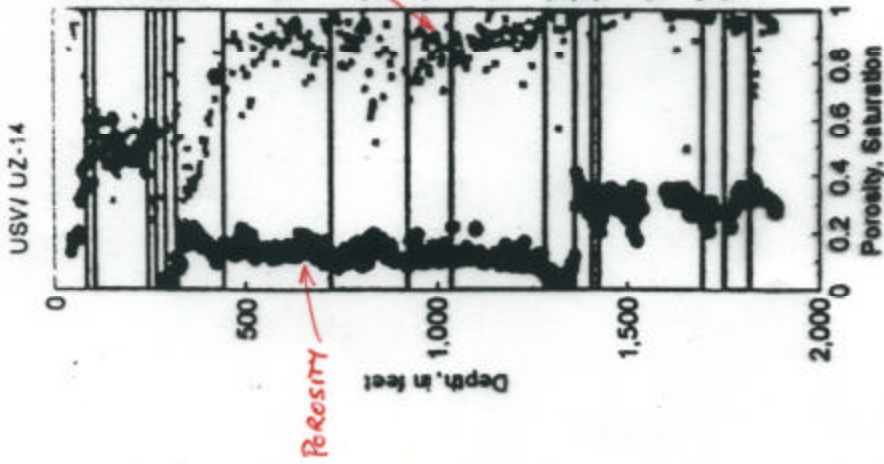
Capillary Fringe \equiv Tension saturated zone

NAPL in Groundwater

$P_c = P_{NAPL} - P_{water}$



Yucca Mtn - UZ-14



1 bar = 100 kN/m²
≈ 10 m of water