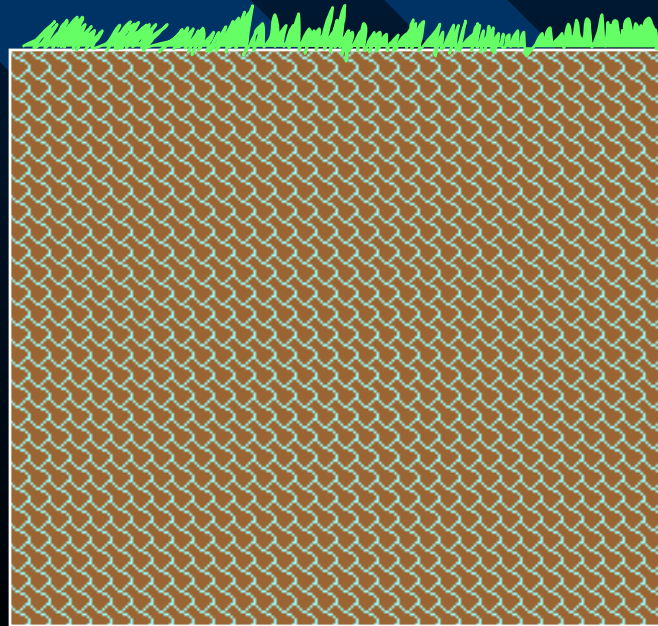


GES175, *Science of Soils*

SOIL WATER



Water Movement

- Surface water moves due to gravitational force



Does water always flow downward?

Energy Concept

Water moves from *high to low free energy*



- difference in free energy causes H₂O to move

Soil Energy Components

(Potential Energy Terms)

- Gravimetric Potential, Ψ_g
- Pressure Potential
 - Submergence Potential, Ψ_{sub}
 - Matric Potential, Ψ_m (capillary and adsorptive forces)
- Osmotic Potential, Ψ_o

Energy Level

+

0

-



Gravitational Potential
height of water above reference

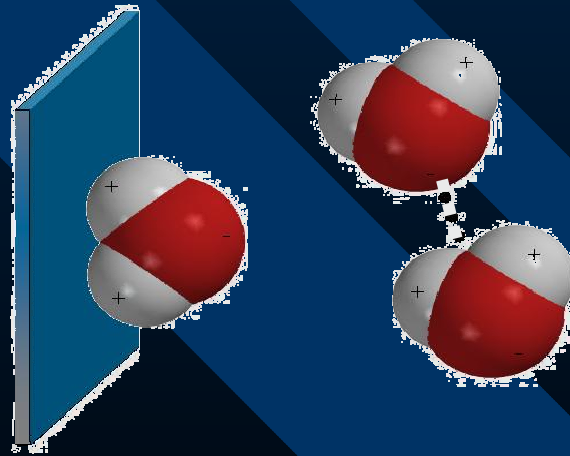
Submergence Potential

Osmotic Potential
dissolved salts

Matric Potential
soils solids

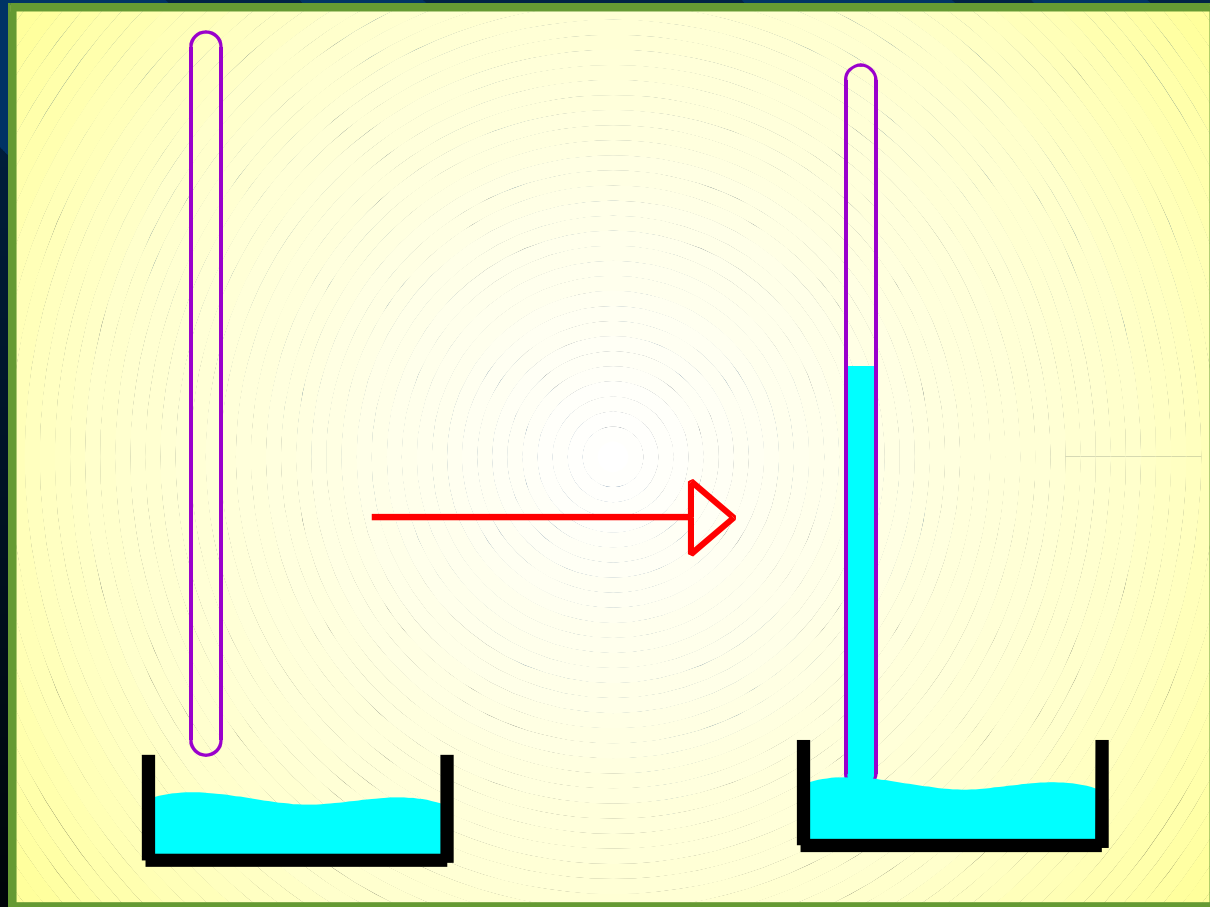
reference
pure water at
fixed elevation

Forces Creating Matrix Potential



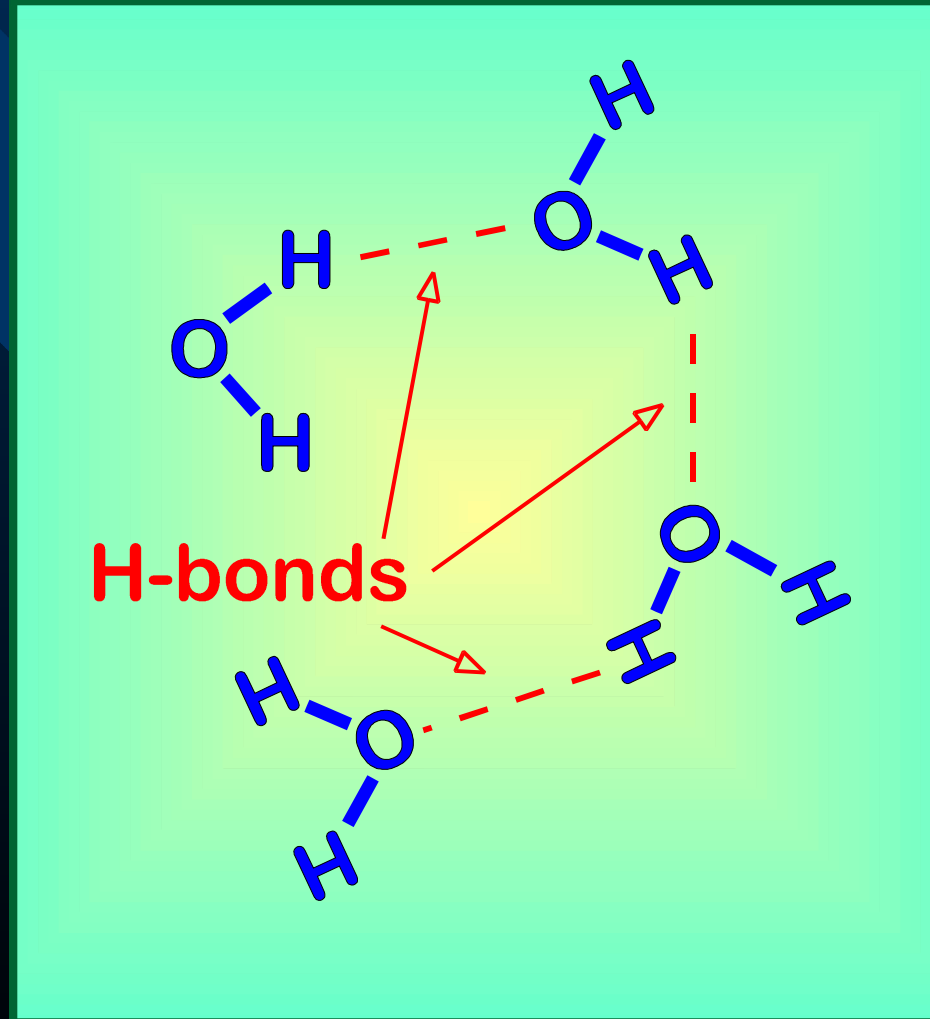
Capillarity

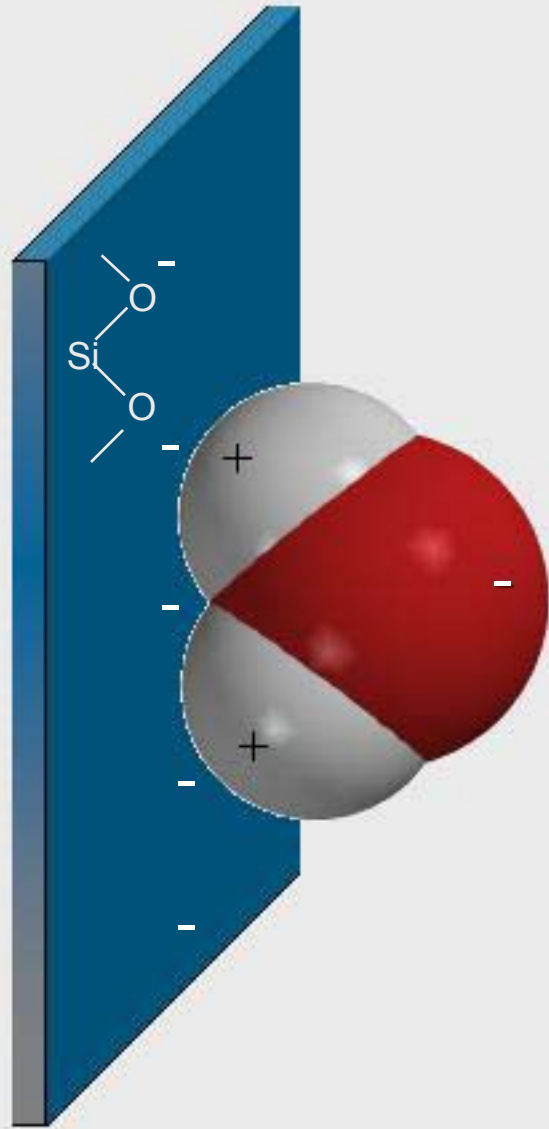
Water moves into capillary soil pores
- due to adhesive and cohesive forces



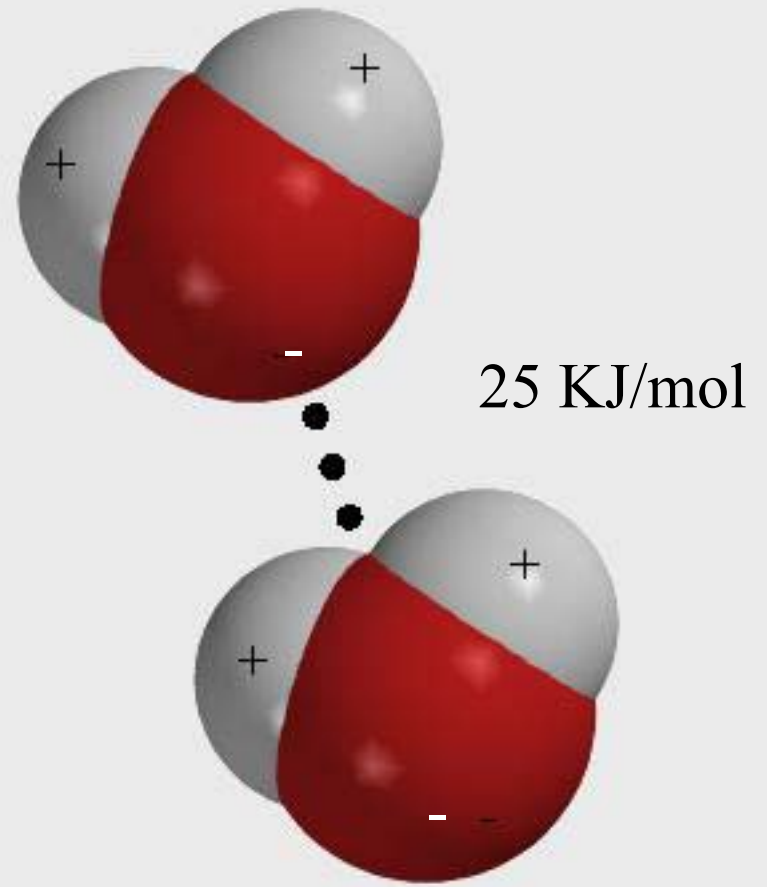
Properties of Water

Hydrogen bonding





Adhesion



Cohesion

Capillary Forces

$$h = \frac{2T \cos \alpha}{r \rho_w g}$$

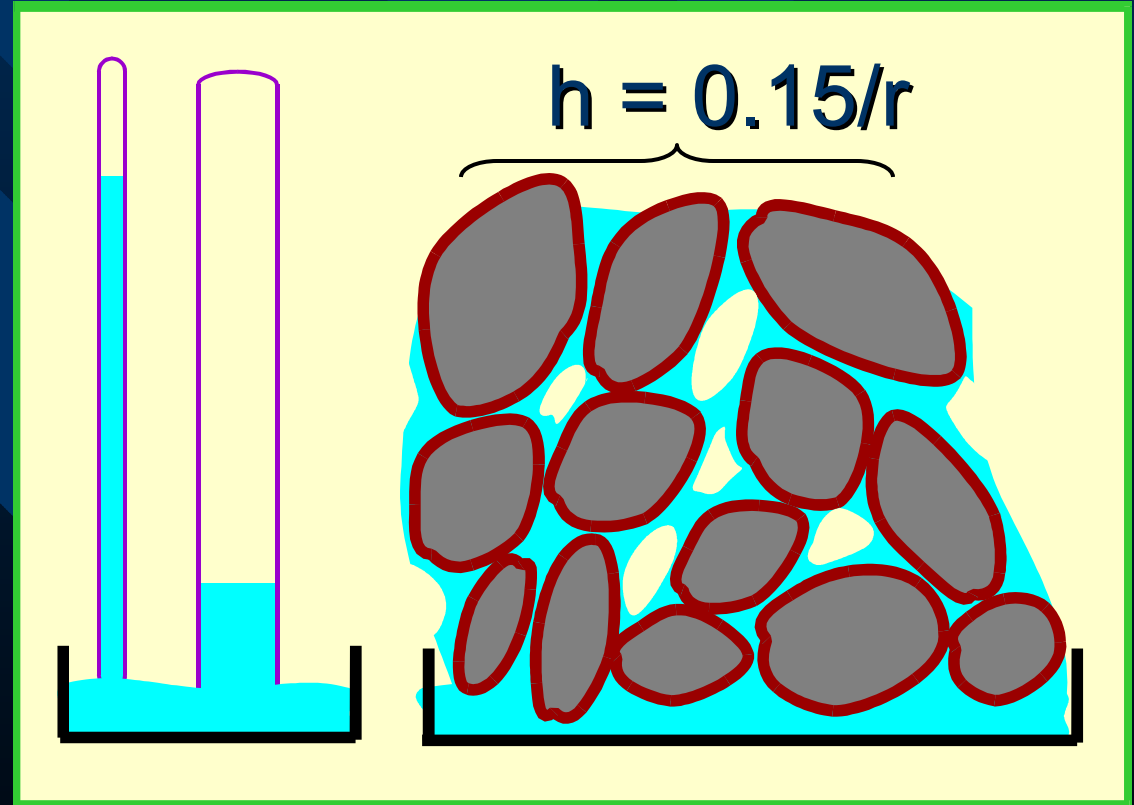
T = surface tension

α = wetting angle

r = radius of pore

ρ_w = density of water

g = gravity



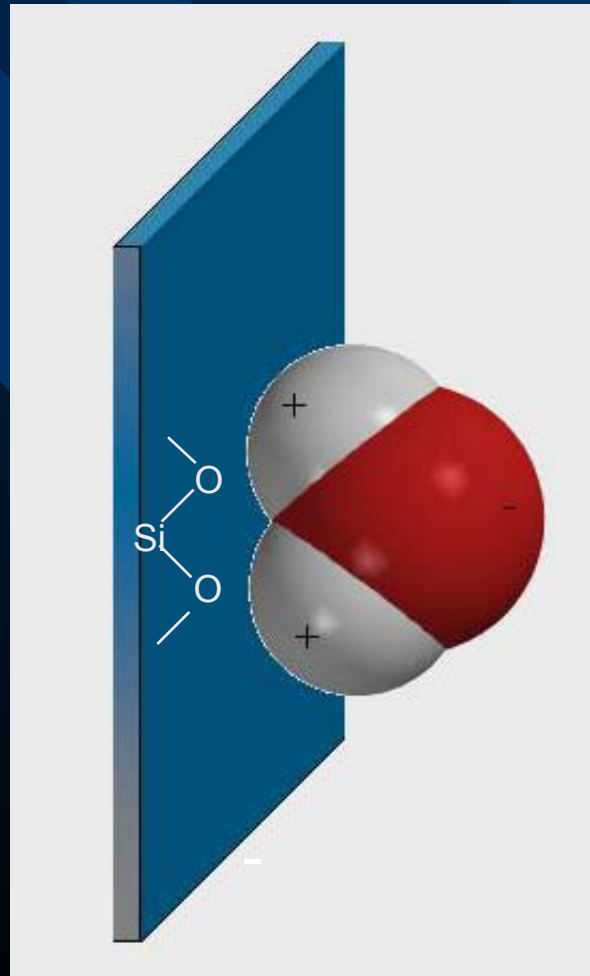
- smaller pores hold water with greater energy
- nondirectional



Furrow irrigation

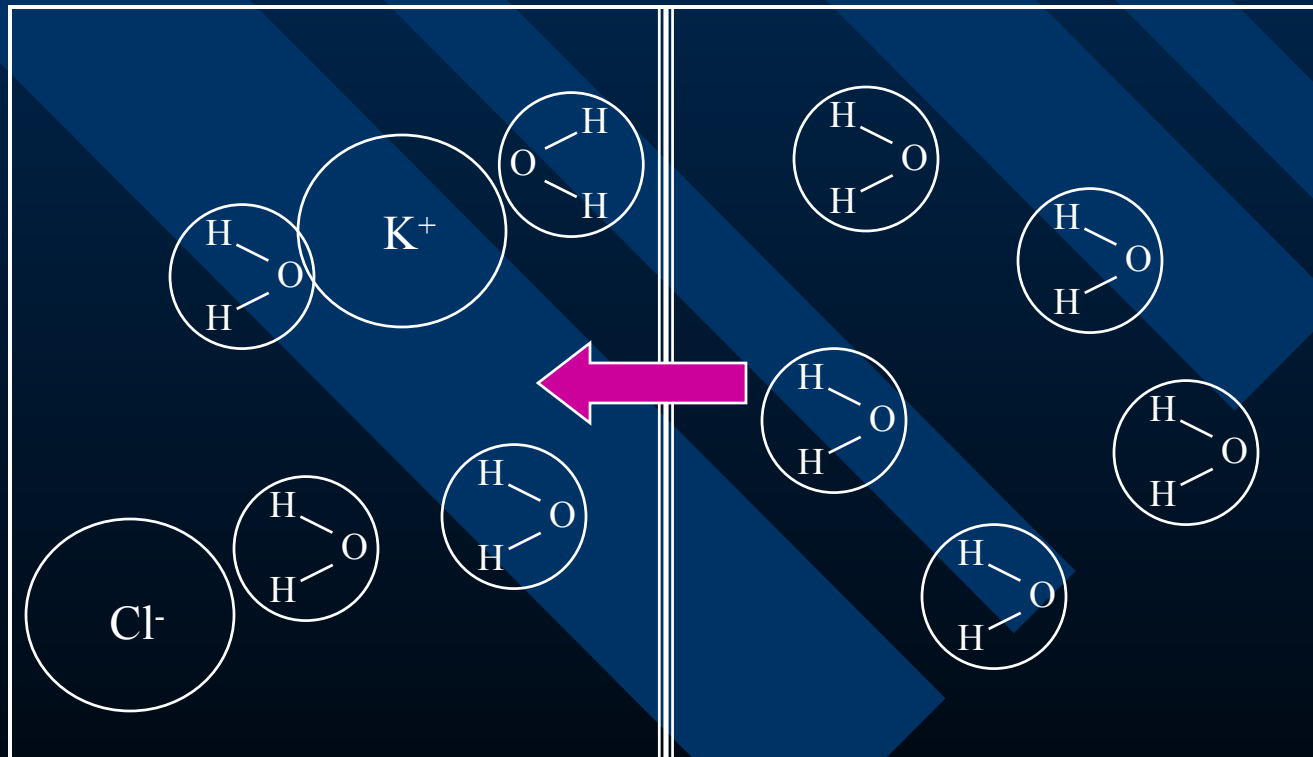
Adsorptive Forces

- water binds strongly to mineral surfaces
- results in thin water film



Osmotic Force

Water movement across semi-permeable membrane



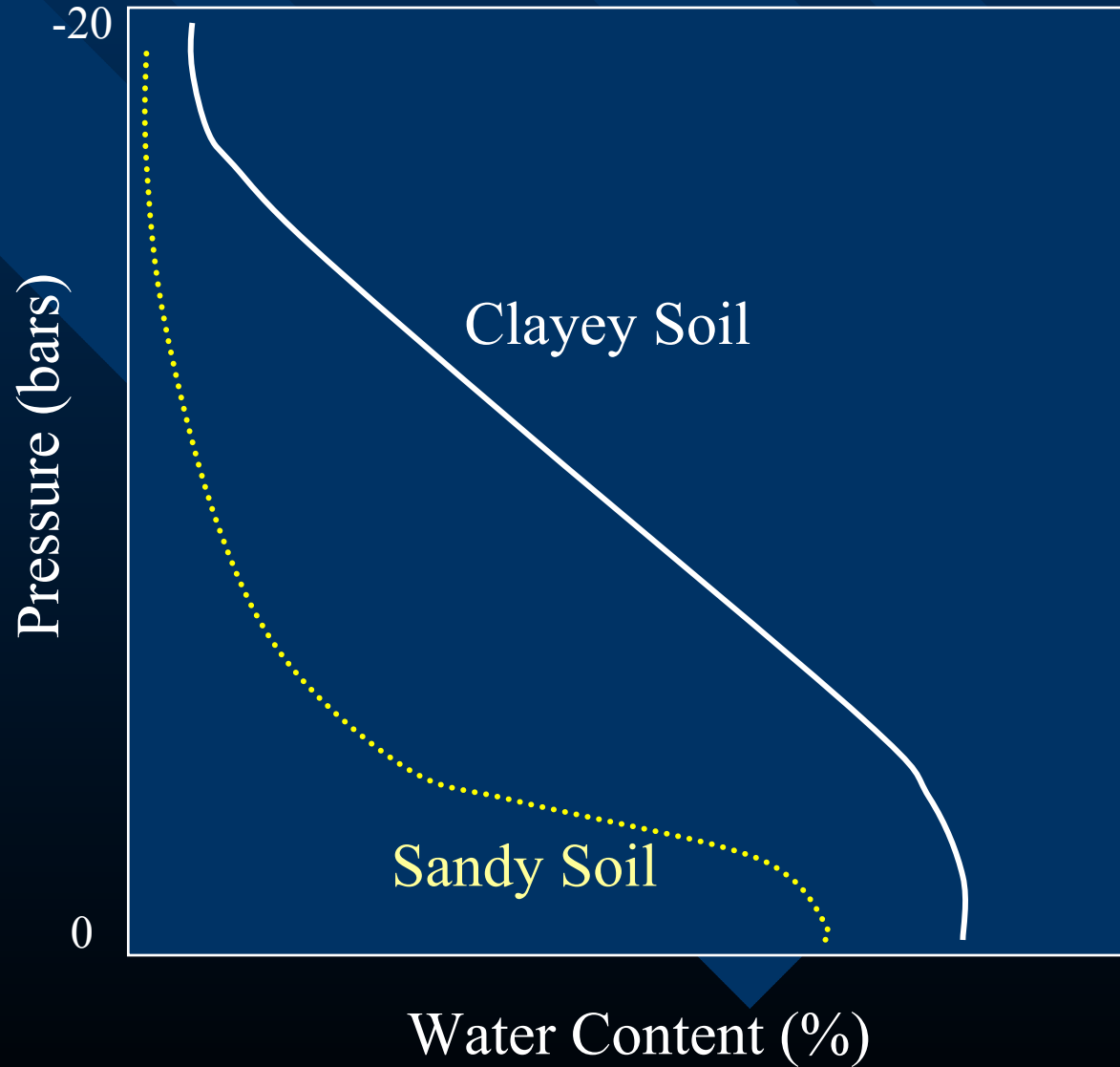
Units (pressure/suction)

$$1 \text{ atm} = 760 \text{ mm Hg} = 1020 \text{ cm H}_2\text{O} = 1 \text{ bar} = 100 \text{ kPa}$$

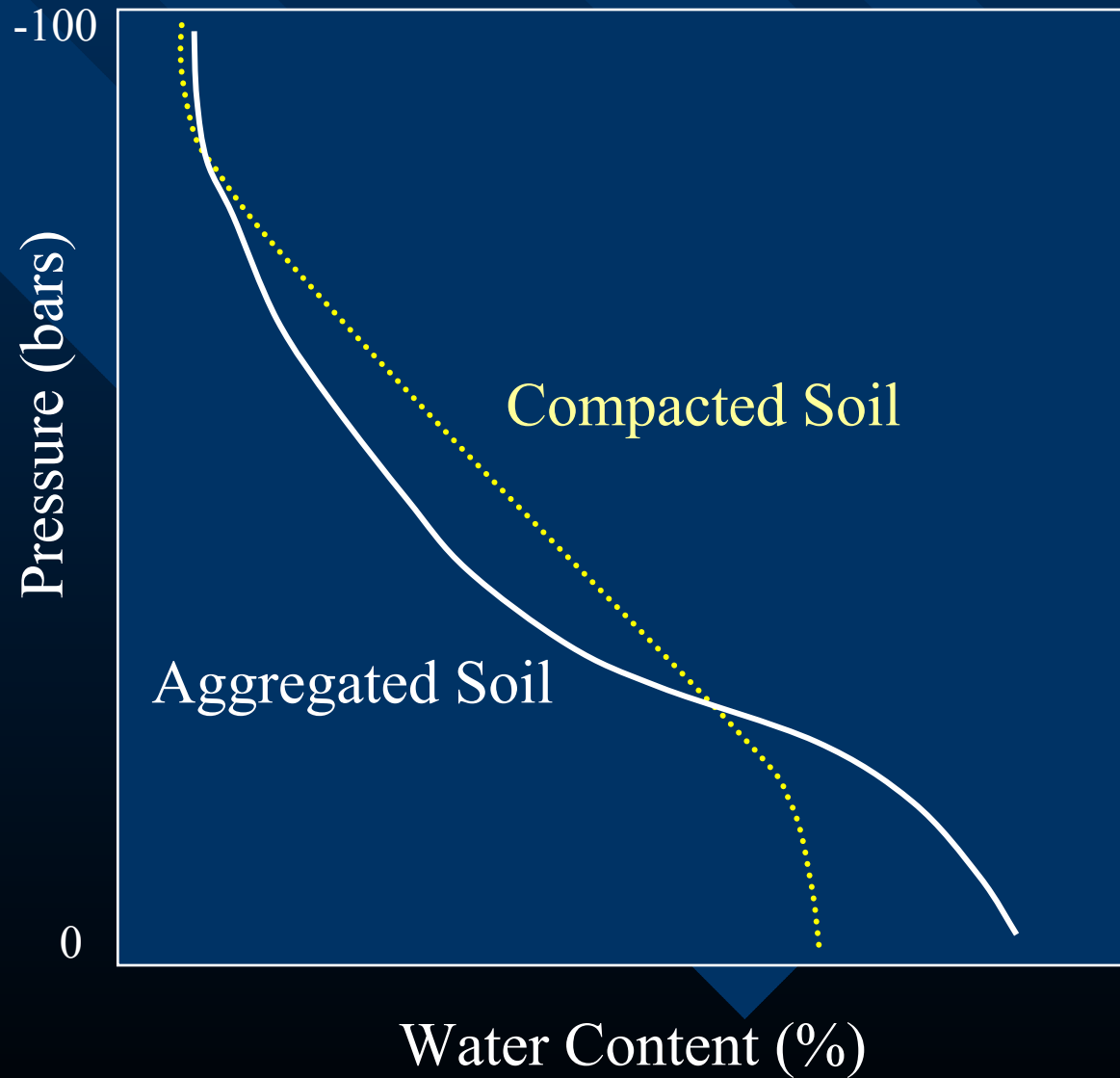
<u>cm H₂O</u>	<u>bars</u>	<u>kPa</u>
300	-0.3	-30
1,000	-1	-100
10,000	-10	-1000
15,000	-15	-1500

see Table 5.1 in text

Water Retention Curves

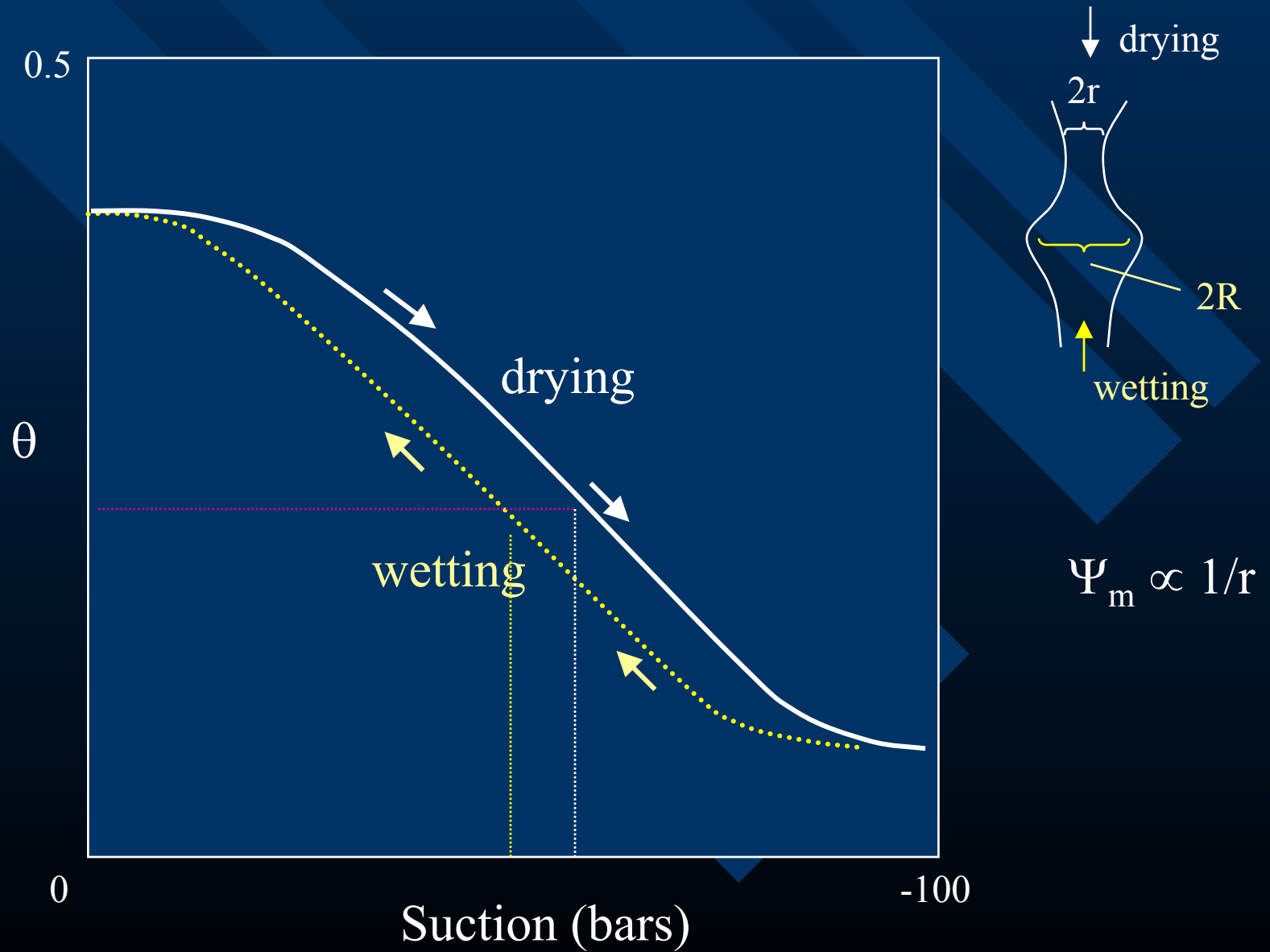


Water Retention Curves

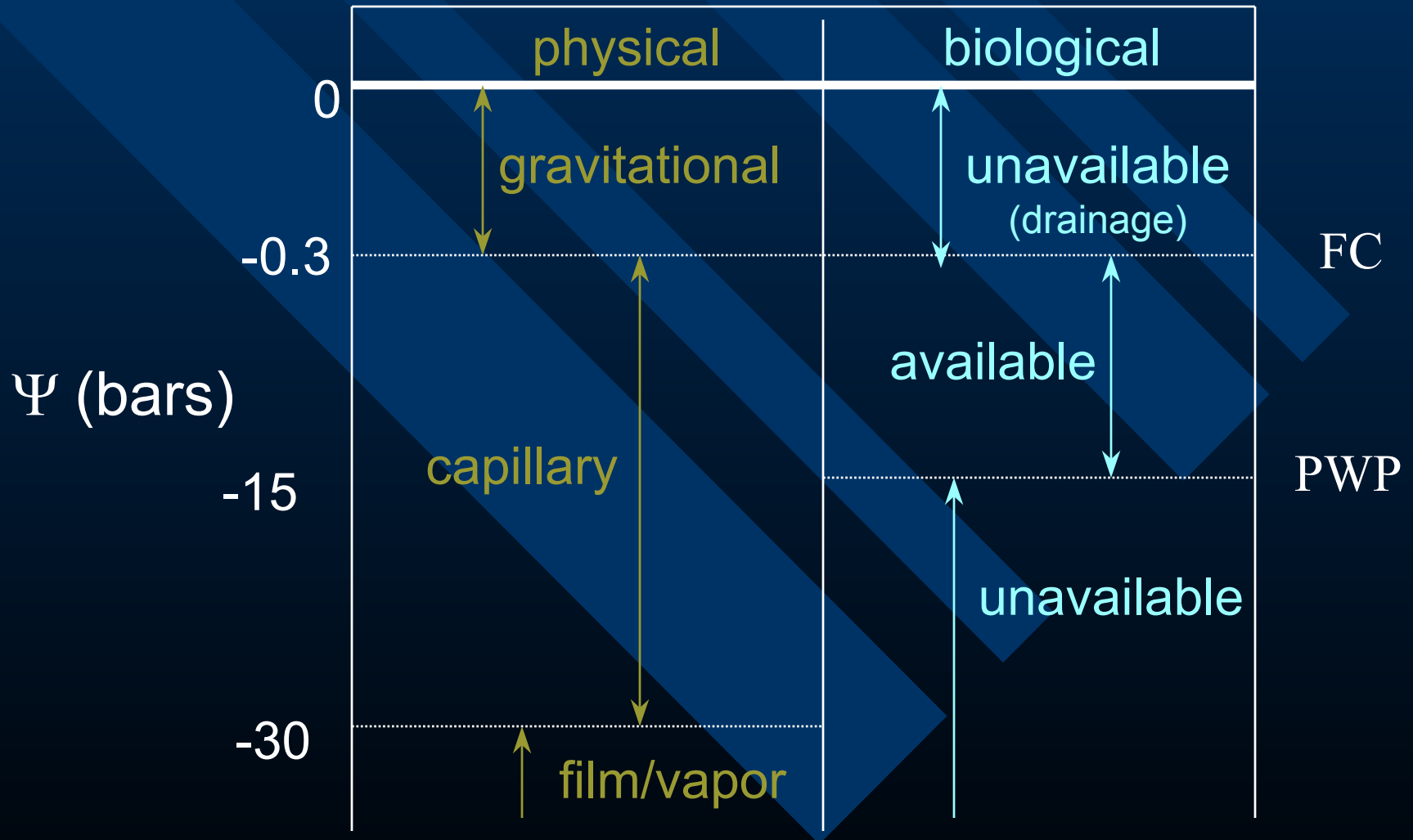


Hysteresis

3.14

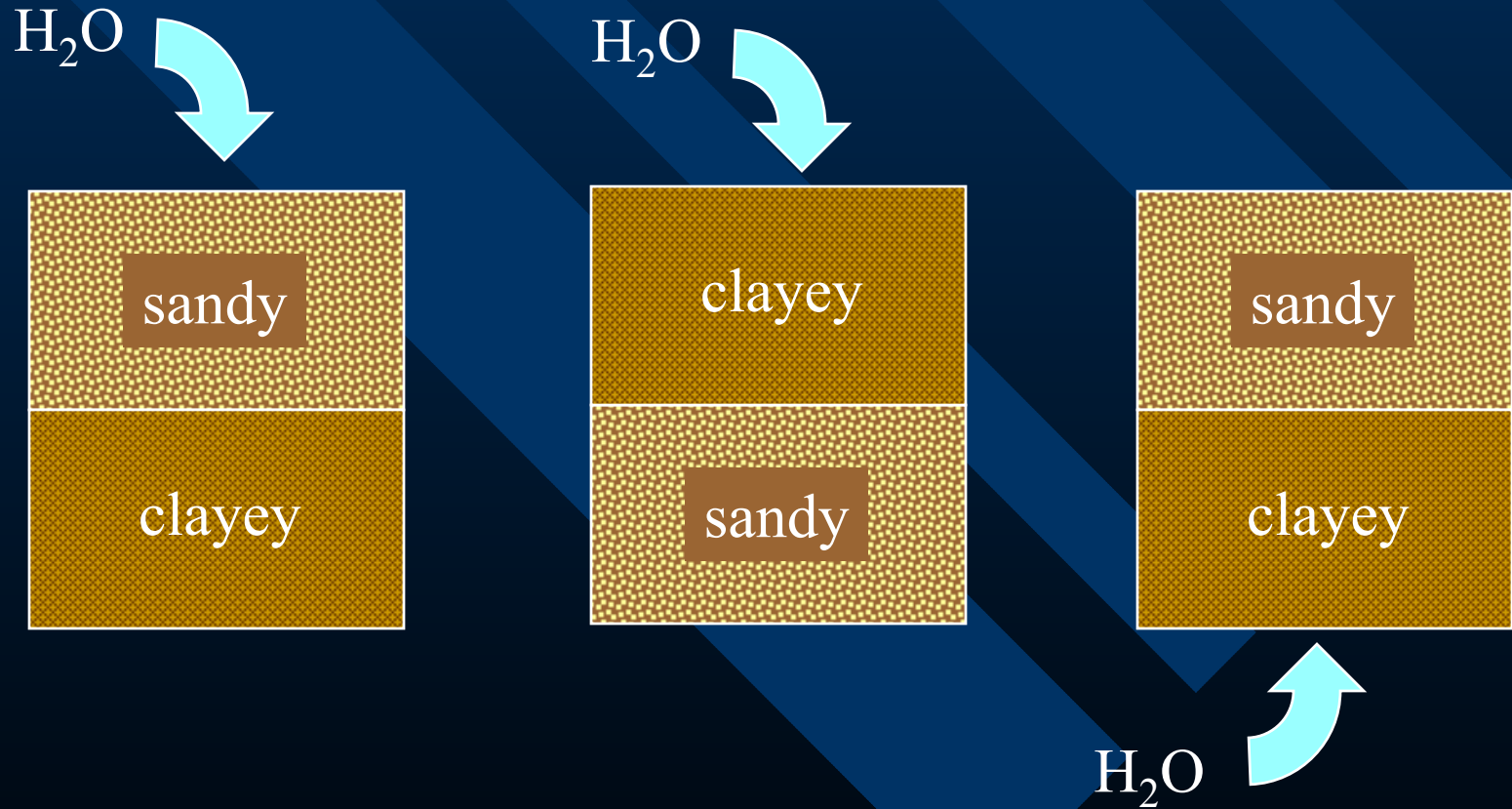


Soil Water: Classification and Availability



values are approximated

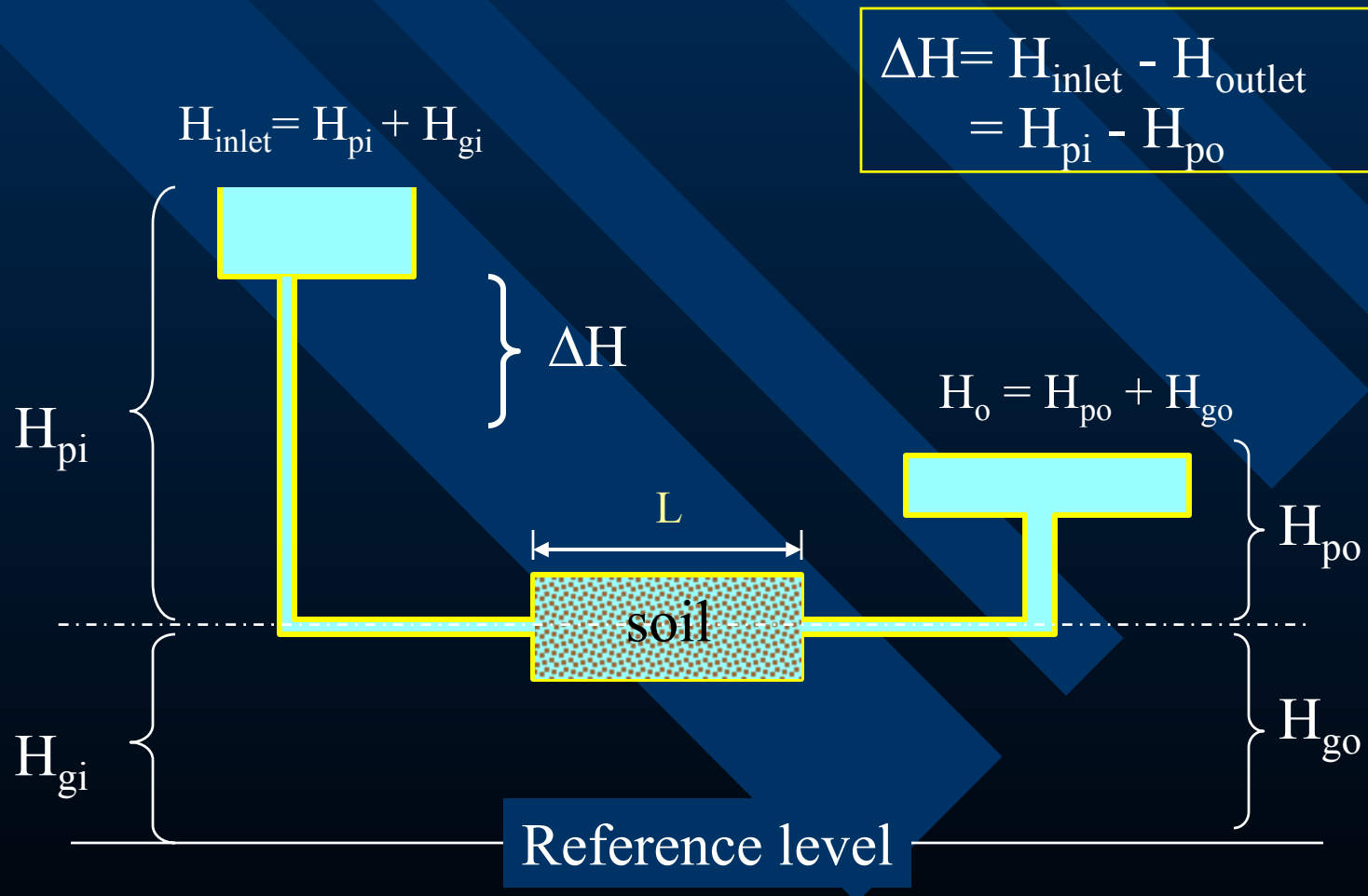
Concepts of Movement



Saturated Flow

3.17

- Horizontal Column

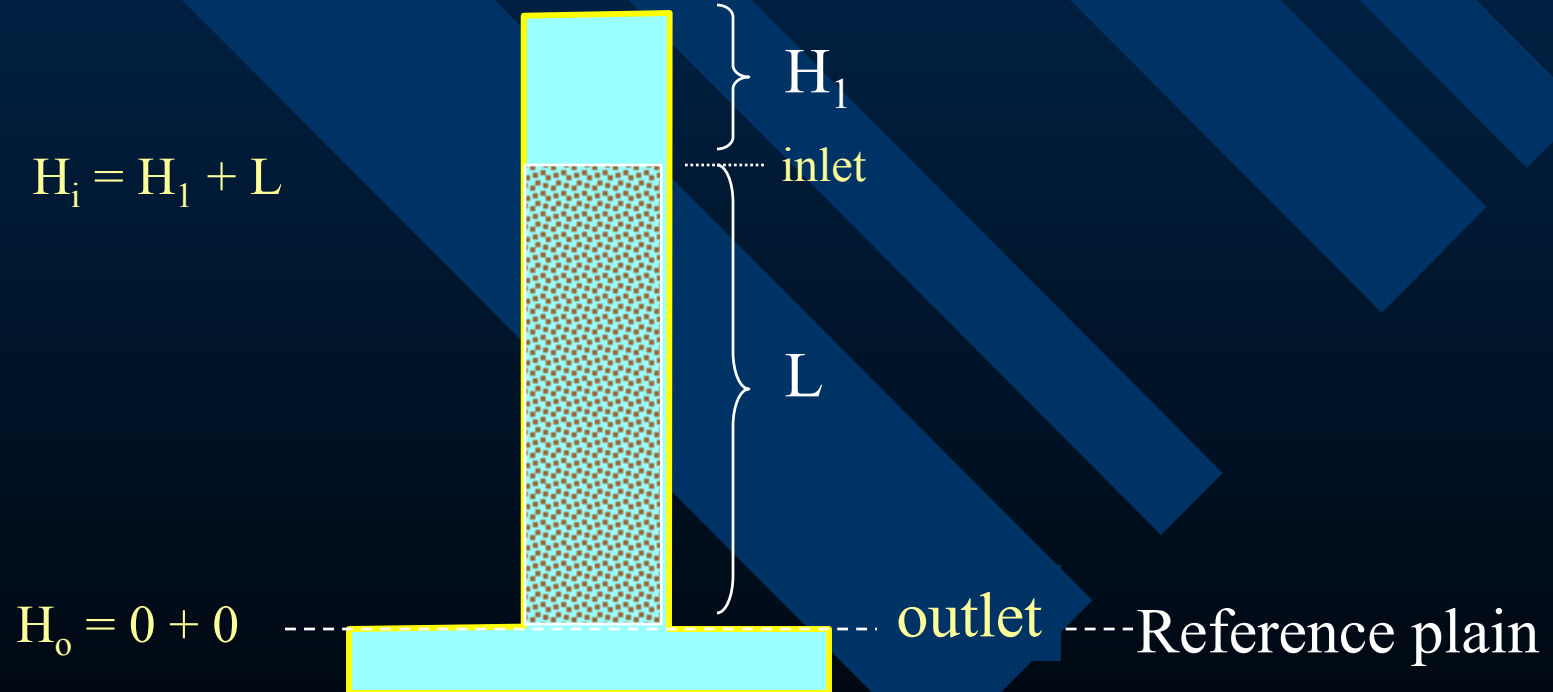


Saturated Flow

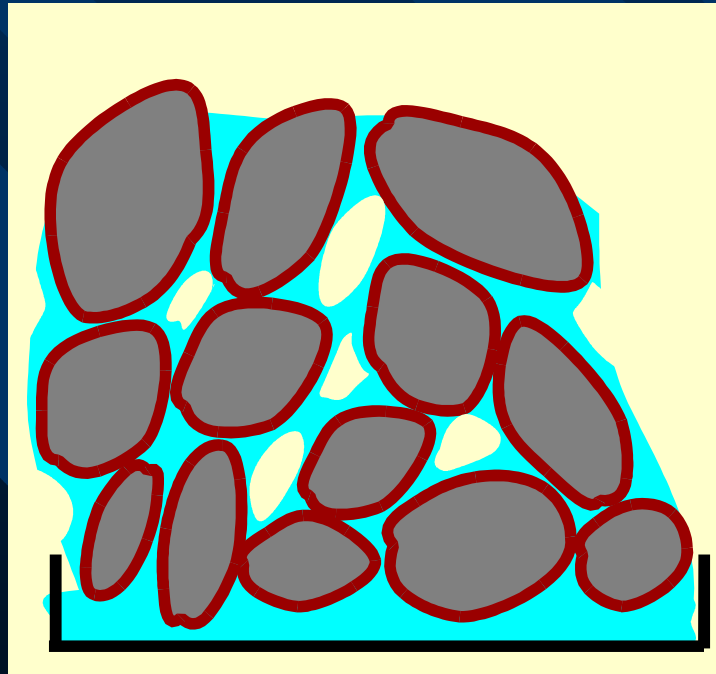
3.18

- Vertical Column

$$\Delta H = H_1 + L$$



Unsaturated Flow



$$q = -k(\theta) \nabla H$$