

# **NARPM Presents...**

## **Focus on Geology**

### **Common Terms in Hydrogeology**

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# Basic Hydrogeologic Terms & Concepts



- Aquifers, Aquitards, & Aquicludes
- Porosity
- Dual Porosity
- Hydraulic Head & Hydraulic Gradient
- Permeability & Hydraulic Conductivity
- Isotropy & Anisotropy

# Aquifers, Aquitards, & Aquicludes

## ◆ Aquifer

- A permeable geologic unit with the ability to store, transmit, and yield water in "usable quantities"

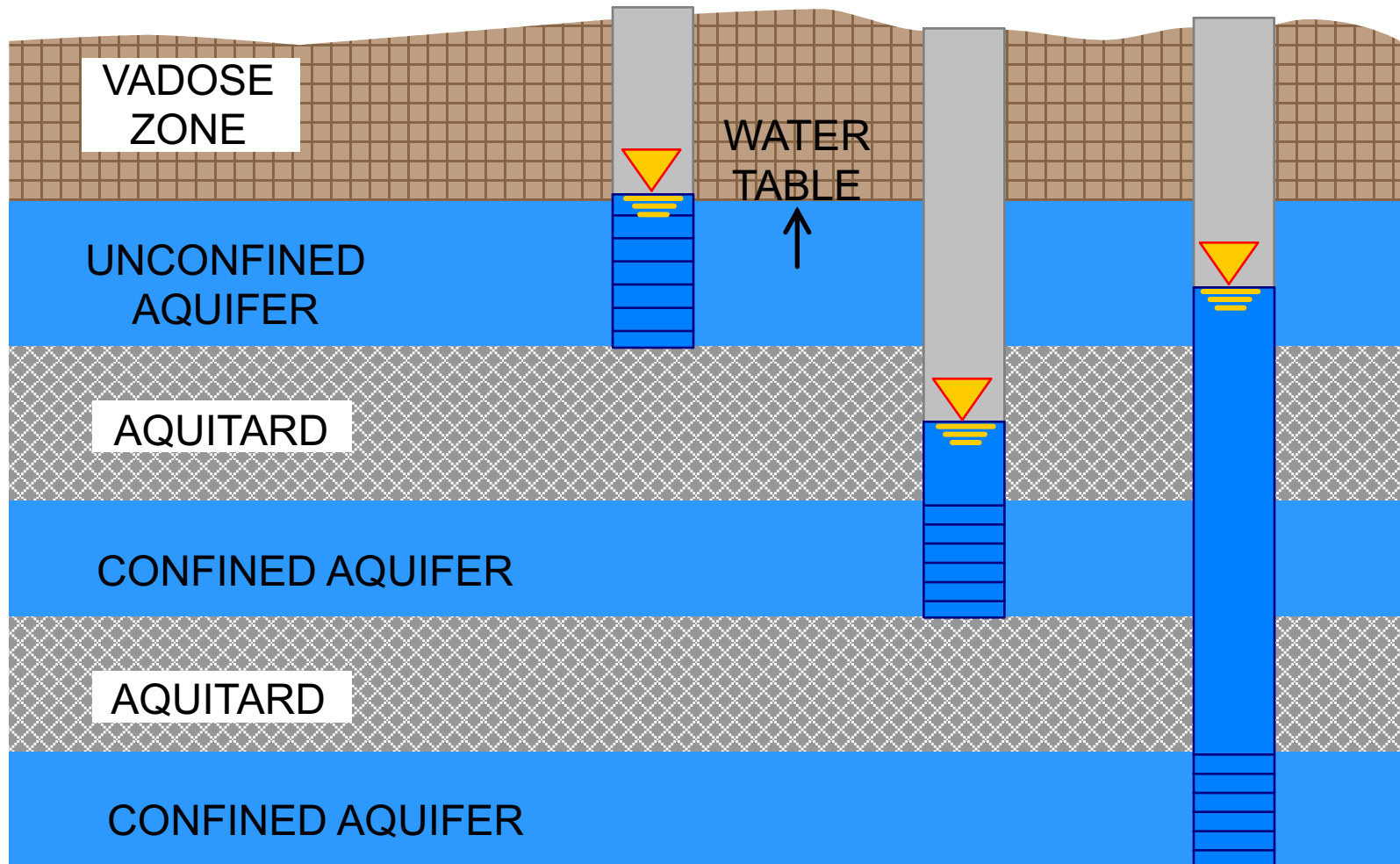
## ◆ Aquitard

- A layer of low permeability that can store and transmit groundwater from one aquifer to another

## ◆ Aquiclude

- An impermeable confining layer.
- The USGS refers to both aquicludes and aquitards as "confining layers" or "confining units"

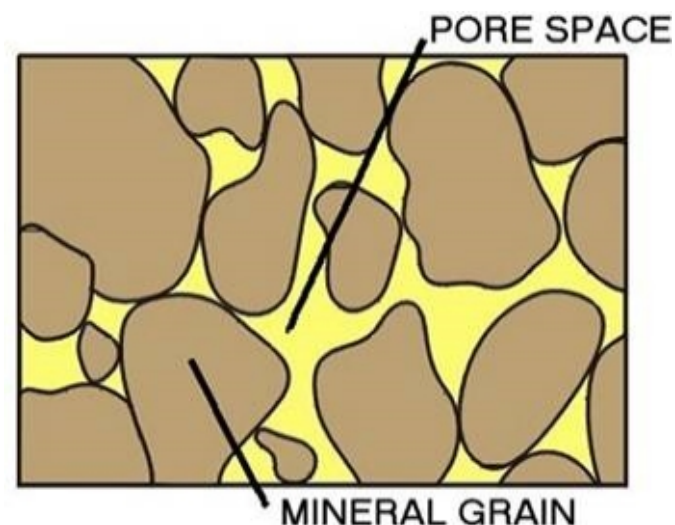
# Aquifers, Aquitards, & Aquicludes



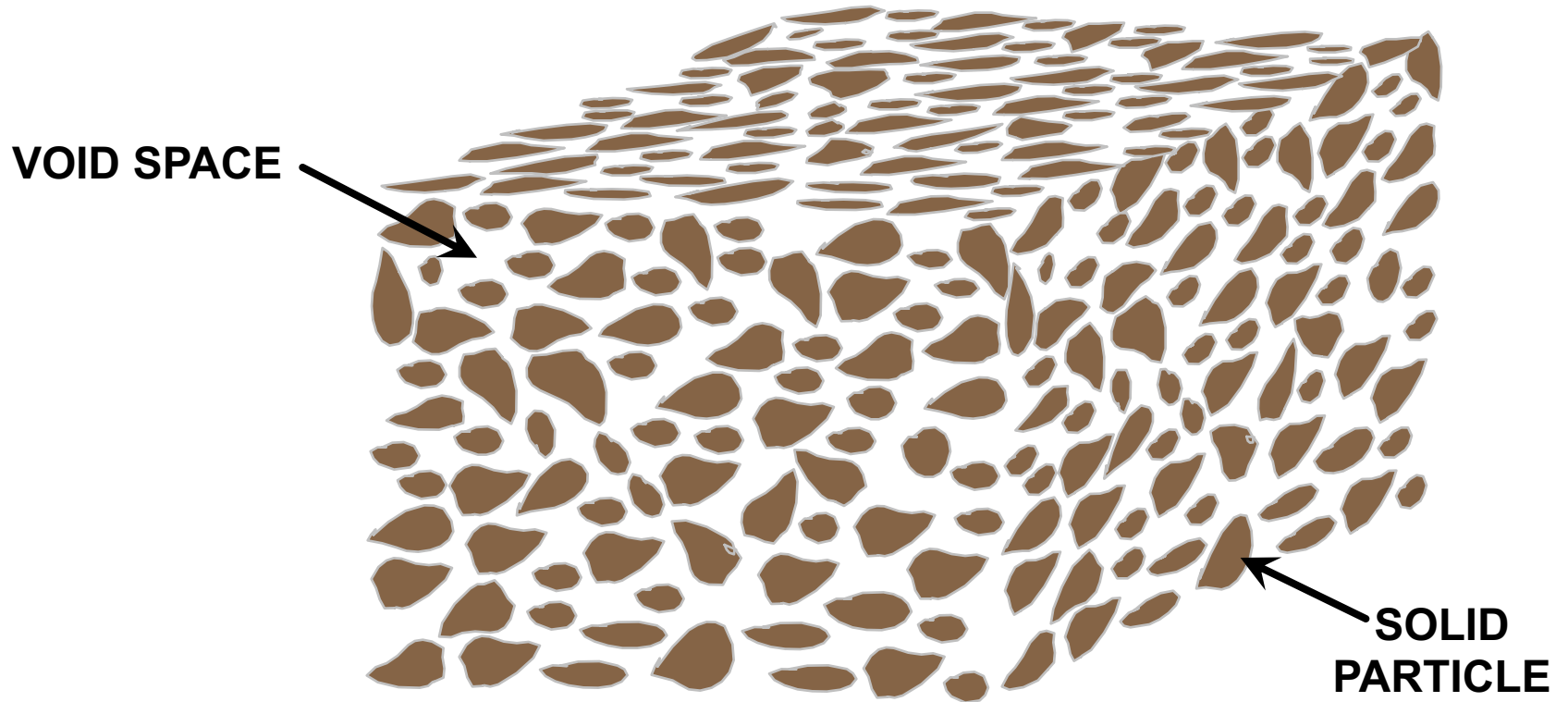


# Porosity

- ◆ Ratio of volume of void space to total volume of medium
- ◆ Where the fluids reside (Groundwater!)
- ◆ NOT the same as Permeability
  - Clay has a very high porosity but a very low permeability
- ◆ Particle size distribution and sorting
  - Well sorted (poorly graded) ... uniform grain size
  - Poorly sorted (well graded) variety of grain sizes



# Porosity



# Dual Porosity Systems

- ◆ Systems in which there are high and low permeability units
- ◆ Nearly all advective flow takes place through the pores in the high permeability materials (mobile porosity)
- ◆ Water in the saturated pore spaces in the low permeability materials (immobile porosity) is dominated by diffusive, rather than advective flux
- ◆ Pore water in the low permeability materials essentially serves as storage for solutes (dissolved contaminants)

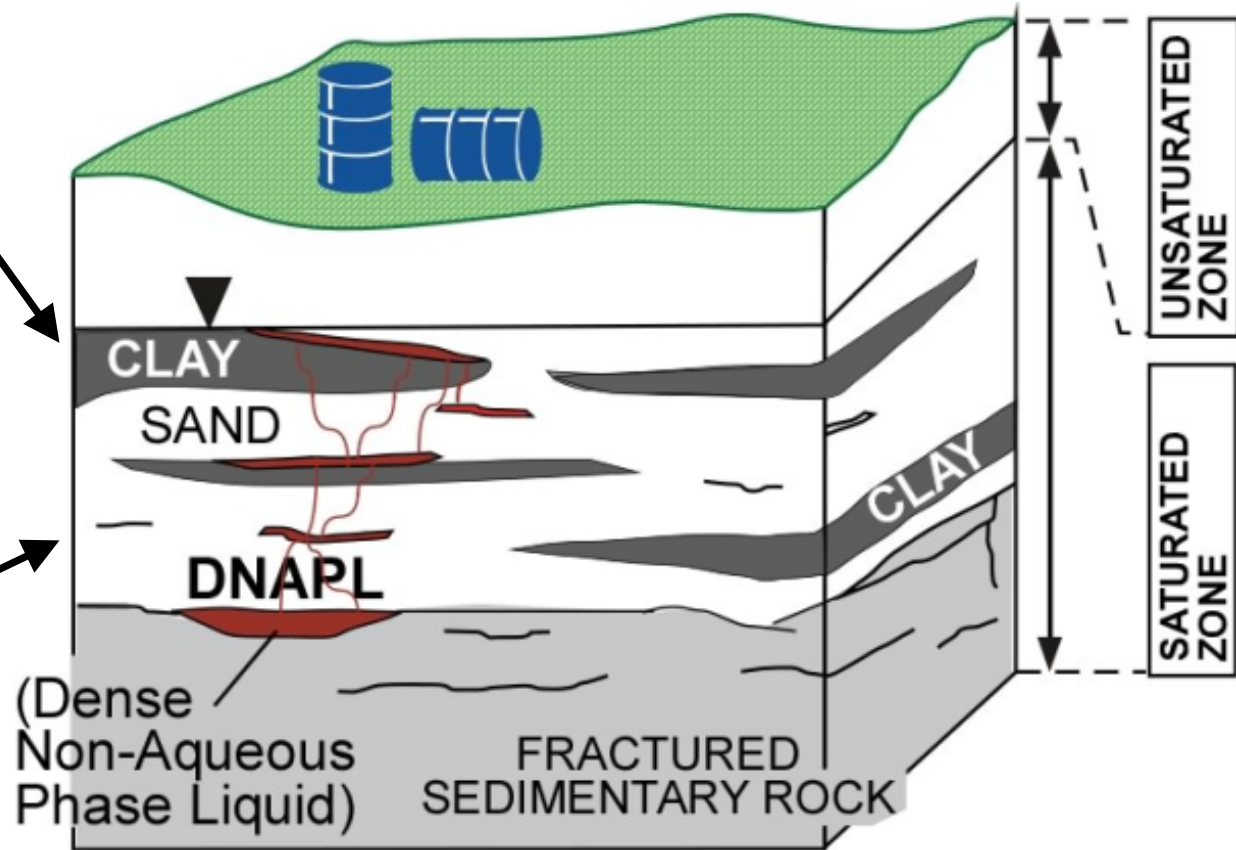
# Dual Porosity in Unconsolidated Media

## Immobile Porosity

Relatively low permeability  
bypassed by advective flow and dominated by diffusive flux

## Mobile Porosity

Relatively high permeability and dominated by advective flow



Source: Chuck Newell and Tom Sale



# Dual Porosity in Fractured Rock

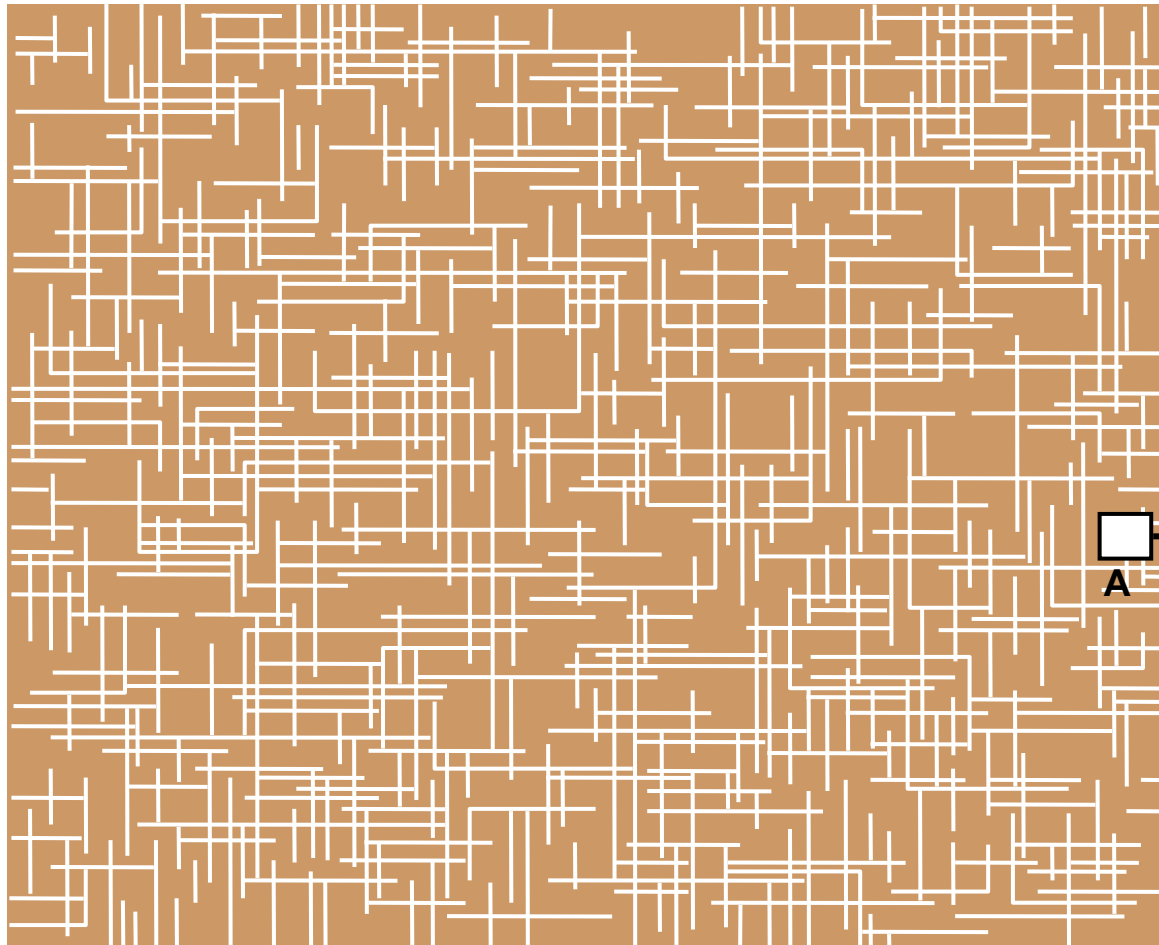
Small Fracture Porosity

and

Large Matrix Porosity

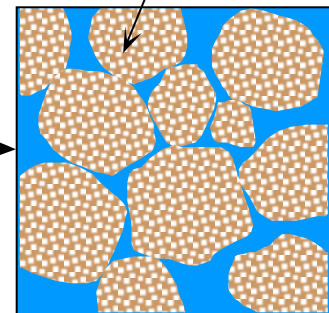
0.1 to 0.001%

2 to 25%



DETAIL A

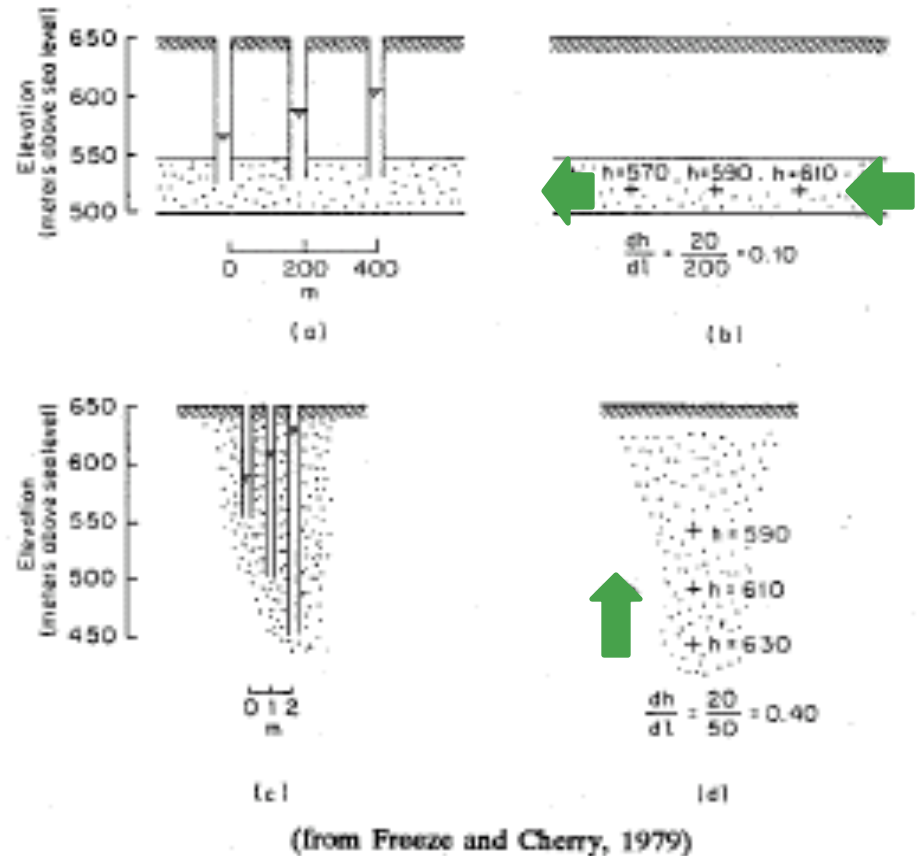
mineral particle



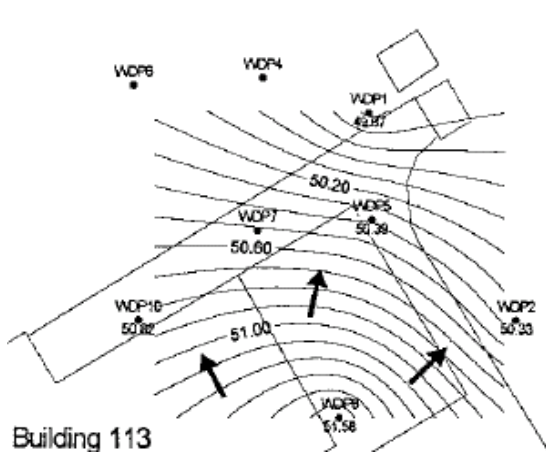
Microscopic  
view of rock  
matrix

# Hydraulic Head & Gradient

- ◆ Driving force (gw flow)
- ◆ Change in potential over distance
- ◆ Vector quantity (direction and magnitude)
- ◆ Three-dimensional

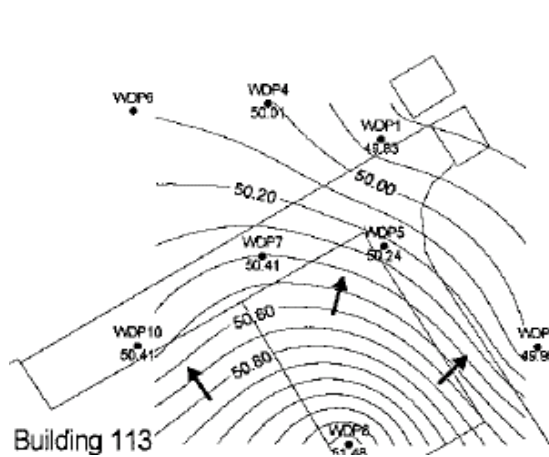


# Hydraulic Gradient Variability with Depth at Pease AFB Site 32



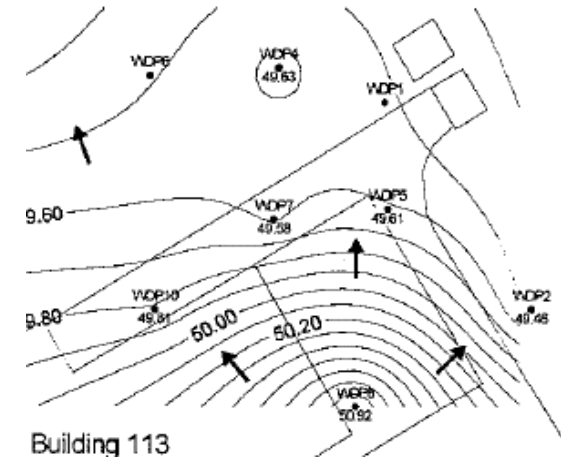
Building 113

Fill/Upper Sand – 50 ft



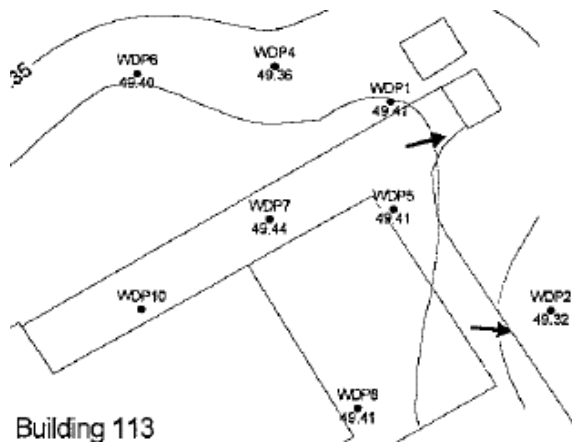
Building 113

Clayey Marine Silt – 44 ft



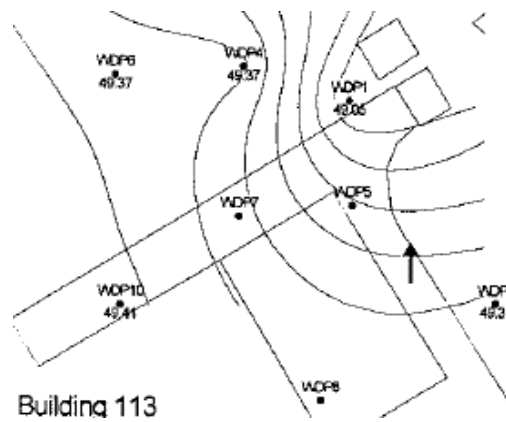
Building 113

Marine Silt & Clay – 40 ft



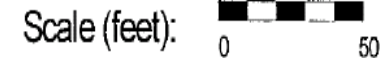
Building 113

Lower Sand – 35 ft



Building 113

Diamicton – 30 ft



# Permeability & Hydraulic Conductivity

## ◆ Permeability (k)

- The ease with which fluid will move through a porous medium
- Property of the medium, such as clay, silt, sand or gravel

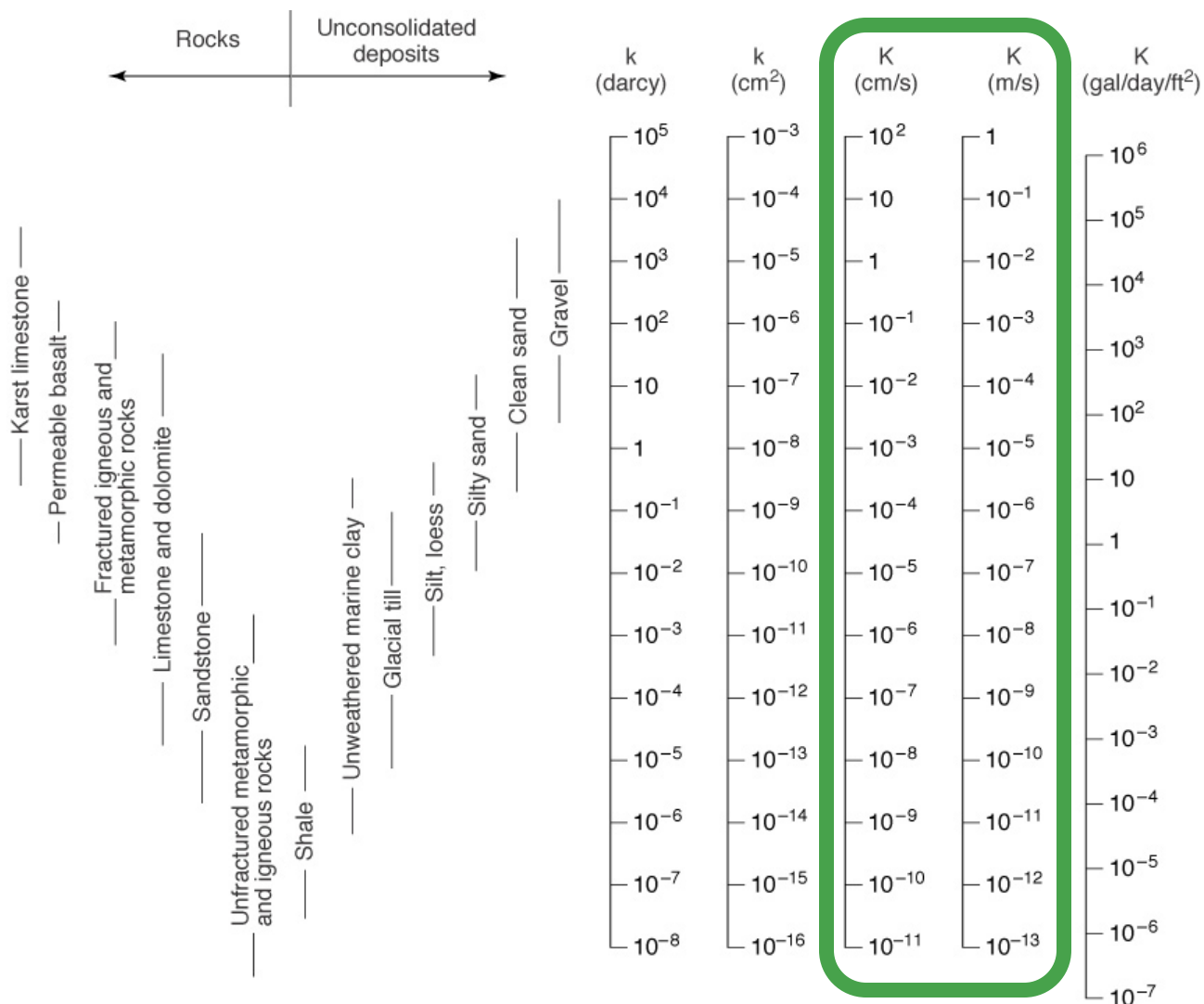
## ◆ Hydraulic Conductivity (K)

- The capacity of a porous medium to transmit water
- Property of the medium and water

## ◆ Note:

- Multiple fluids may coexist in the same system, such as water and NAPL
- Each fluid has a different conductivity within the same permeability regime
- Conductivity is dependent on the density and viscosity of the fluid

# Hydraulic Conductivity





Flow (>99%)

Storage (>99%)

$10^{-2}$  cm/sec

$10^{-4}$  cm/sec

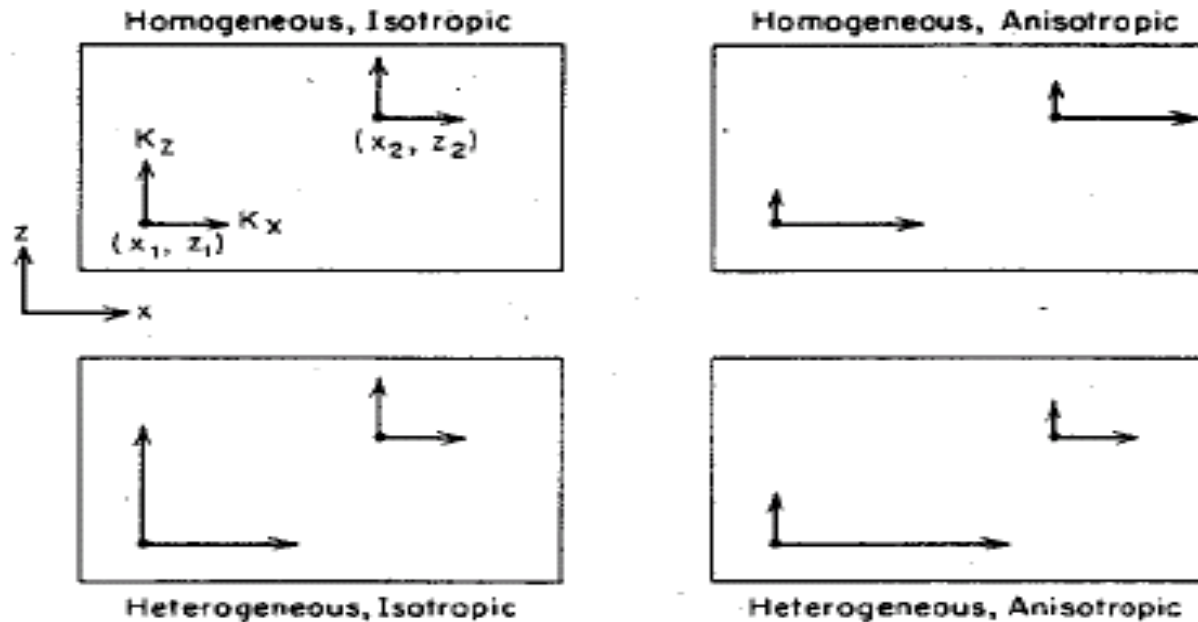
$10^{-6}$  cm/sec



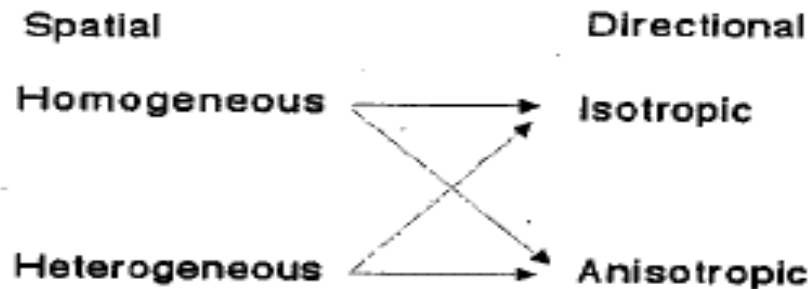
# Homogeneity and Isotropy

- ◆ Homogeneous
  - Variable has same value regardless of position in space
- ◆ Heterogeneous
  - Variable has a different value depending on its position in space
- ◆ Isotropic
  - Variable has same value regardless of the direction in which it is measured
- ◆ Anisotropic
  - Variable has a different value depending on the direction in which it is measured

# Homogeneity - Heterogeneity Isotropy - Anisotropy

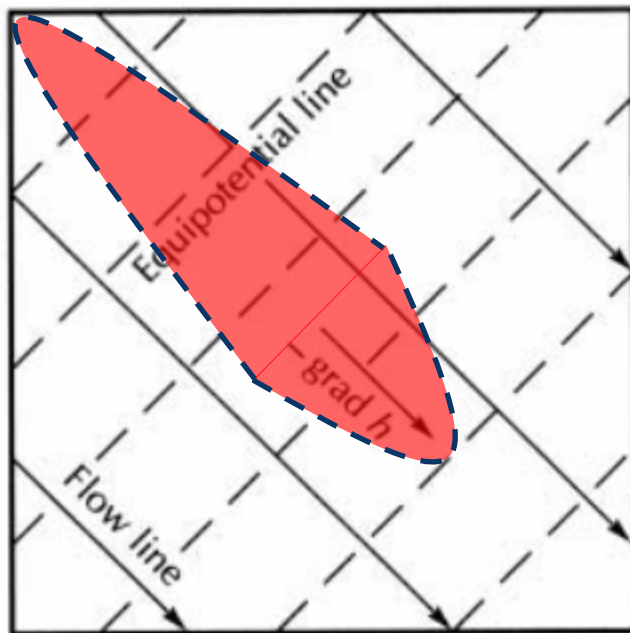


(from Freeze and Cherry, 1979)

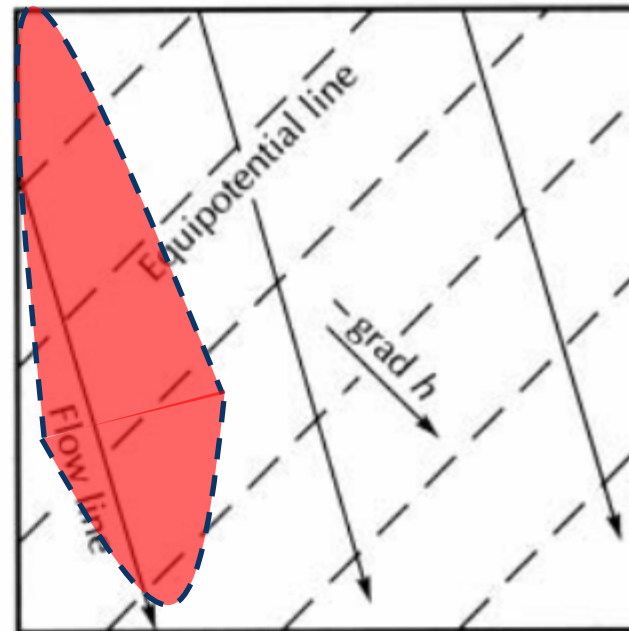




# Isotropic vs. Anisotropic



Isotropic



Anisotropic

# Complexity of Contaminated Groundwater Aquifers

- ◆ Contaminated aquifers are highly diverse (even within similar environments and the same contaminants)
- ◆ However, most contaminated aquifers share similar physical attributes based on the geological setting and the contaminants involved
- ◆ These similar physical attributes provide for:
  - Generic discussion of physical and chemical transport processes
  - Standardized approaches to characterization and monitoring
  - Foundation for the *Conceptual Site Model* (CSM)
- ◆ Site-specific characteristics provide the details of the CSM





# Questions?

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