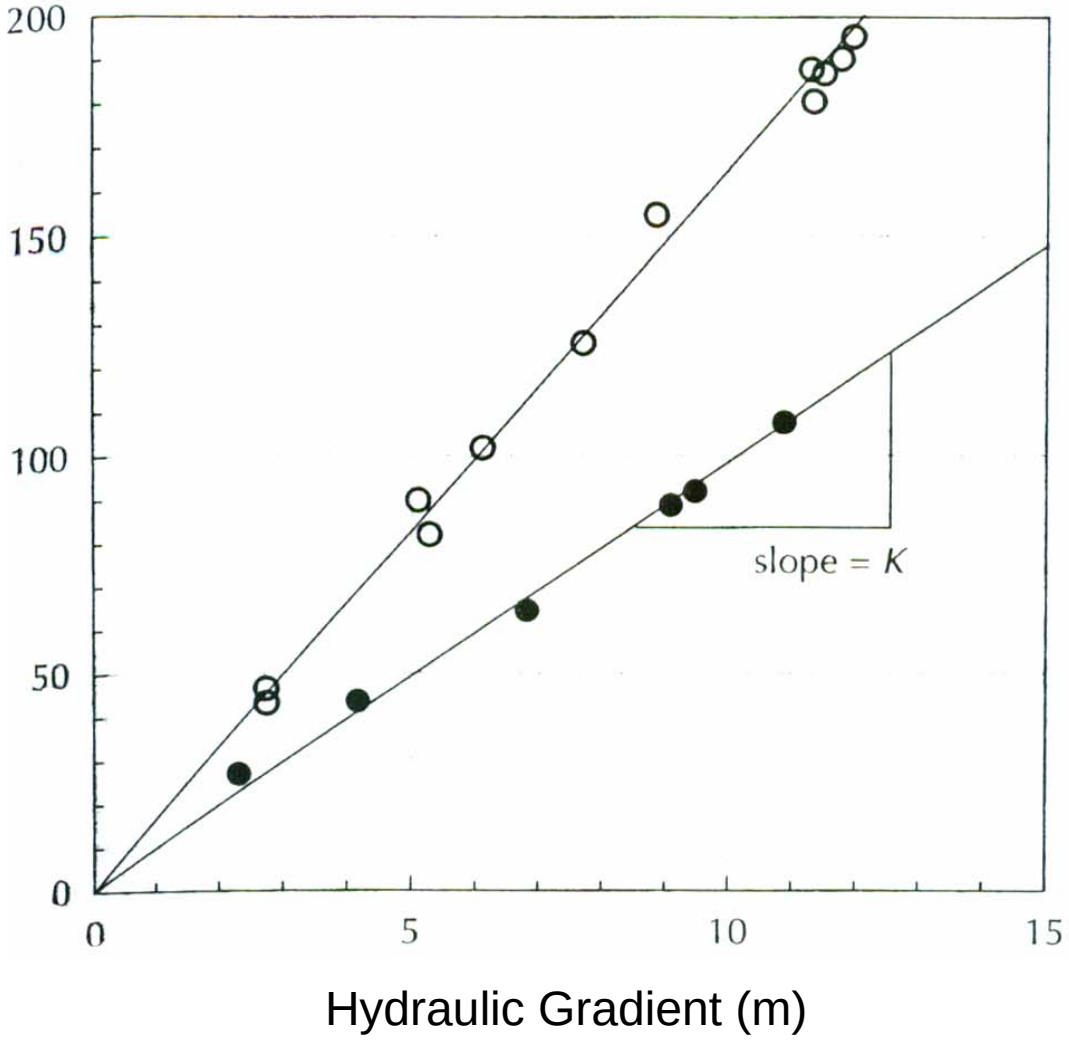
Darcy's Law



◄ FIGURE 3.13
Original data from Darcy's 1856 experiments that show a linear relationship between specific discharge and hydraulic gradient for two different sands. *Source: Hornberger, Raffensperger, Wiberg and Eshleman,* Elements of Physical Hydrology. *© 1998. The Johns Hopkins University Press. Used with Permission.*

$$q_x = -K_x \frac{dh}{dx}$$

Hydraulic Conductivity $K_{sat} = \frac{Cd^2\gamma}{\mu}$

- A function of the properties of the porous medium and the fluid passing through it.
  - d is the mean pore diameter of the medium
  - C is the shape factor, a constant reflecting the shape and connectivity of the pores,
  - γ is the specific weight of the fluid (the force exerted per unit volume of the fluid),
  - μ is the dynamic viscosity, the resistance of the fluid to shearing forces.
- A viscous, dense fluid like crude oil will move more slowly than water through soil.

Porosity $\phi = \frac{V_a + V_w}{V_s} = 1 - \frac{\rho_b}{\rho_m}$

- Two types:
  1. Primary porosity: The porosity due to the initial voids created when the rock or sediment formed.
  2. Secondary porosity: The porosity formed after sediment deposition or rock formation.
- Secondary porosity arises from seismic activity and chemical and physical weathering.
  - Some of the processes involved: erosion, dissolution, deposition, fracturing.

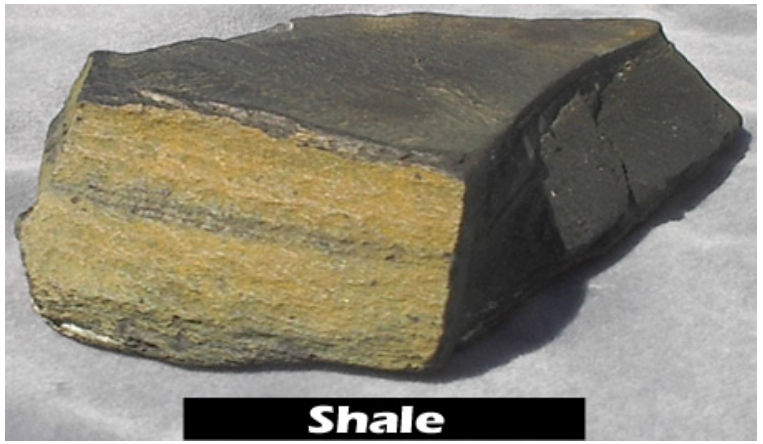
Hydrologically Significant Rocks

- These are common rocks that play a big role in groundwater flow and storage.

Basalt

Granite

Limestone



Summary

- Darcy's Law: water flow is proportional to the hydraulic head gradient.

$$\vec{q} = -\vec{K}\nabla h$$

- Hydraulic conductivity K
  - Is a function of the properties of the soil/rock matrix (permeability) and of the fluid.
  - In unsaturated conditions, a function of θ as well, K(θ)
  - Has the largest natural range of any geophysical variable.
- Porosity and permeability are related but not the same.
  - Permeability depends on size distribution, shape, and connectivity of pores as well as number/area.
  - Substances with large, straight, well connected pores have the highest permeability and therefore K.