Environmental Geology - Geology 406/506

USEFUL DEFINITIONS & DARCY'S LAW

- Soil Water - water contained in soil pores
- Pores - empty/void space
- Vadose Zone - zone of unsaturated conditions
- Water Table - upper limit of the saturated zone
- Aquifer - saturated zone/contains water
- Groundwater - water contained in aquifer. Flows freely into a well
- Unconfined aquifer - no confining geologic structure on the aquifer (aquifer pressure about the same as the atmosphere)
- Confined Aquifer - confining geologic formation on top of aquifer. Aquifer pressure usually greater than atmospheric
- Artesian aquifer - confined aquifer where water is so pressurized that it reaches the surface without pumping
- Perched Aquifer - geologic formation (usually a clay lens) within vadose zone that intercepts water and creates a small, localized aquifer
- Infiltration - movement of water through vadose zone into saturated zone
- Recharge - water entering an aquifer from precipitation
- Overland flow - precipitation is faster than infiltration and excess water runs over surface of land
- Residence Time - time a water molecule remains in a given hydrologic compartment

DARCY'S LAW: Q = KIA

1. HYDRAULIC CONDUCTIVITY

- **symbol - K**
- **units - length/time EX. (m/day)**
- **Ability of a particular material to allow water to pass through it**

2. HYDRAULIC HEAD/FLUID POTENTIAL

- **symbol - h**
- **units - length EX. (m)**
- **a measure of energy potential (essentially is a measure of elevational/gravitational potential energy)**
- **is the driving force for groundwater flow**
- **WATER ALWAYS FLOWS FROM AREA OF HIGH HEAD TO AREA OF LOW HEAD (even if this means it may go "uphill"!)**
- **measure head by sinking a well then measuring the level (elevation) to which the water rises in the well in relation to a reference point which is taken as zero meters (usually sea level)**
- **hydraulic head determines the hydraulic gradient**

3. HYDRAULIC GRADIENT

- **symbol - I**
- **units - unitless (why? because length divided by length cancels out the units!)**
- **this is essentially the slope of the water table, and groundwater flow will be "down" this slope**
- **sink two wells and measure head. Then find the difference between them and divide this by the flow length (distance between the two wells)**
- **EXAMPLE: head in well one = 100 feet. Head in well two= 10 feet. Distance between the two wells is 10 feet. So the hydrauluic gradient is: 100 feet-10 feet/10 feet = 9**

4. AREA OF FLOW

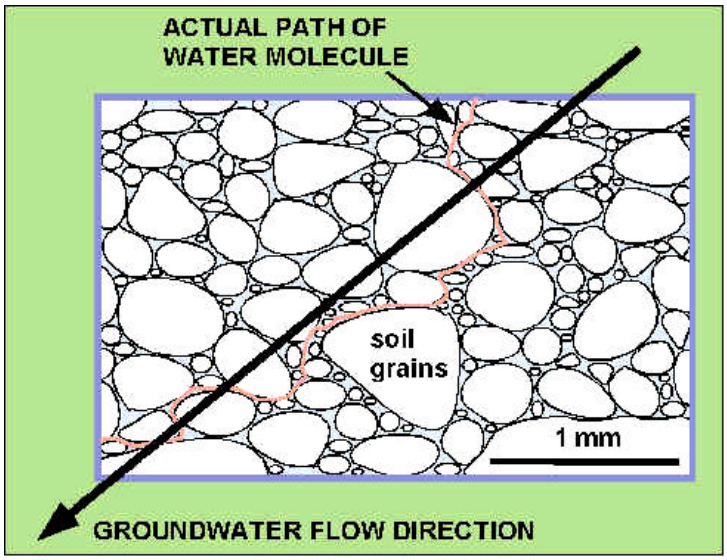
- **symbol - A**
- **units - distance squared EX. (m^2)**
- **Cross-sectional area of flow. (i.e. aquifer width x thickness)**

5. DISCHARGE

- **symbol - Q**
- **units - volume/time EX. (m^3/day)**
- **volume of water flowing through an aquifer per unit time**
- **FIND WITH DARCY'S LAW Q = KIA**

6. FLUX

- symbol - v
- units - distance/time EX. (m/sec)
- v = Q/A = KI
- this is a velocity measure and gives the IDEAL velocity of groundwater (assumes that water molecules can flow in a straight line through the subsurface).
- this is ideal because it doesn't account for tortuosity of flow paths (this means that the water molecules actually follow a very windy path in and out of the pore spaces and so travel quite a bit slower in reality than the flux would indicate).



TORTUOSITY OF FLOW PATHS
Black arrow indicates overall flow direction;
red line indicates actual flow path; blue = pore space
v = how fast ; Q = how much

7. POROSITY

- symbol - n
- units - %
- percent of void space (empty space) in soil or rock. Represents the path water molecules can follow in the subsurface
- Primary porosity - intergranular
- Secondary porosity - fractures, faults etc.

8. DARCY FLUX

- **symbol - v_x**
- **units - distance/time EX. (m/sec)**
- **$v_x = Q/An = KI/n$**
- **This is the ACTUAL velocity of groundwater and DOES account for tortuosity of flow paths by including porosity in its calculation.**

REMEMEBER ! JUST BECAUSE POROSITY (n) IS HIGH DOESN'T MEAN HYDRAULIC CONDUCTIVITY (K) WILL BE HIGH! ! For example, clay has a high n, but a low K (because it has very small pores).

- **Water table contour lines are similar to topographic lines. They essentially represent "elevations" in the subsurface. These elevations are called the HYDRAULIC HEAD. And, just like a ball rolling down a hill, water in the subsurface will go from an area of high head (elevation) to an area of low head (elevation)**
- **Water table contour lines can be used to tell which way groundwater will flow in a given region.**
- **Lots of wells are drillled and hydraulic head is measured in each one**
- **Water table contours are drawn that join areas of equal head (these are called equipotential lines - it's like "connect-the-dots"!)**
- **Groundwater flow IS ALWAYS PERPENDICULAR to the water table contour lines (or flow lines)**

DARCY'S LAW

$Q = KIA$