2-25-20 Particle Tracking

① Concept I

$$Q = KA\, dh/dL$$

↑ L^3/Time volumetric flux

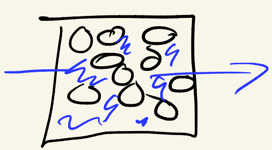
$$\frac{Q}{A} = k\, dh/dL = q \quad [L/T]$$

↑ flux per area

effective porosity

$$Q = V(An_e)$$

$$V = Q/An_e \neq q!$$



② Processes of solute transport

1. Advection - movement with the gw flow
2. Diffusion - movement from high to low concentration
3. Dispersion - Random displacement
4) Sources & sinks
5. Reaction - decay, sorption consumption.

↑ MT3D

MODPATH is lagrangian Particle tracking -

we follow each particle individualy

$$X_p^{n+1} = x_p^n + \Delta x + \cancel{Z}$$

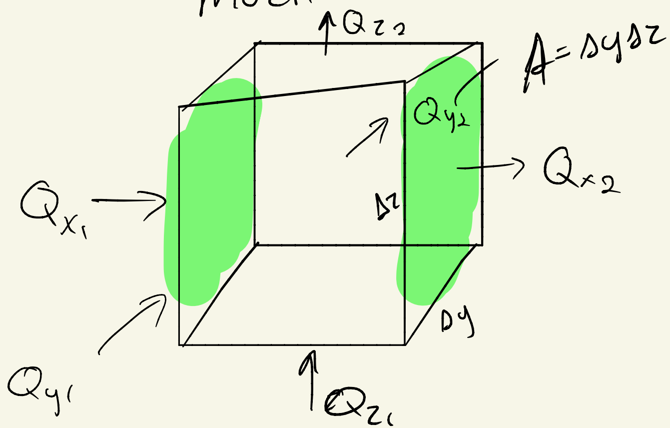
Position of particle at time $n+1$

Position @ time n

advection displacement

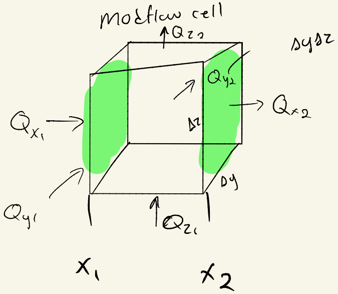
Random displacement of dispersion $= 0$ for MODPath

modflow cell



$$V_{x_1} = \frac{Q_{x_1}}{n \Delta y \Delta z}$$

$$V_{x_2} = \frac{Q_{x_2}}{n \Delta y \Delta z}$$



$$V_{x_1} = \frac{Q_{x_1}}{n\,\Delta y\,\Delta z}$$

$$V_{x_2} = \frac{Q_{x_2}}{n\,\Delta y\,\Delta z}$$

$$V_x = A_x(x - x_1) + V_{x_1}$$

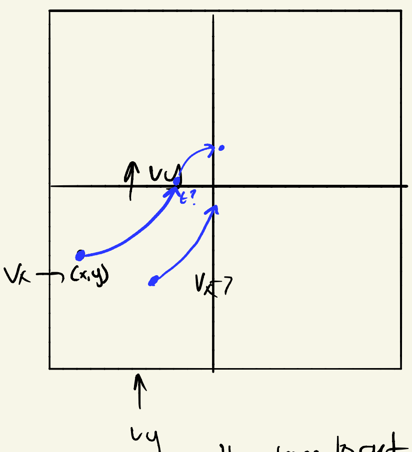
$$A_x = \frac{V_{x_2} - V_{x_1}}{\Delta x}$$

$$\frac{dV_x}{dt} = \left(\frac{dv_x}{dx}\right)\left(\frac{dx}{dt}\right) = A_x V_x$$

$$\frac{dV_x}{V_x} = A_x\,dt$$

$$\ln\left(\frac{(V_x)_t}{V_{x t_1}}\right) = A_x(t - t_1)$$

$$x_t = x_1 + \frac{1}{A_x}\left[(V_x)e^{A_x(t-t_1)} - V_{x_1}\right]$$



How long to get out of grid cell in x direction →

$$\Delta t_x = \frac{1}{A_x}\ln\left(\frac{V_{x2}}{V_{x t_1}}\right)$$

1. figure out velocity gradients across cells ← This is from MODFLOW solution
2. Place particle — ie give it an inital condition
3. Figure out which face it is exiting the grid cell by calculating the time to each boundary
4. Figure out travel time across cell + exit location
5. Repeat for next cell until it exits the domain or reaches a sink