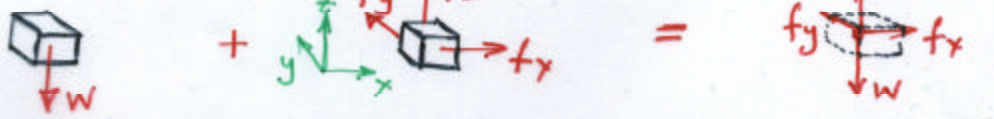
3.6 Non-Aqueous Fluid Penetration (Moving Groundwater)

Two situations: ① NAPL saturates medium → No capillary forces
② NAPL and water

3.6.1 NAPL Saturated

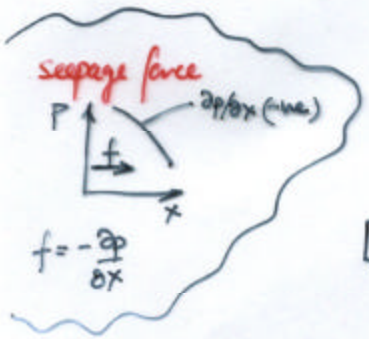
What pressure gradient to move fluid?
What direction of movement?

$dx\,dy\,dz = dV$



BODY FORCE SEEPAGE FORCE RESULTANT

$$dV\rho g \begin{Bmatrix} 0 \\ 0 \\ -1 \end{Bmatrix} + dV \begin{Bmatrix} -\partial/\partial x \\ -\partial/\partial y \\ -\partial/\partial z \end{Bmatrix} p = \underline{F}$$



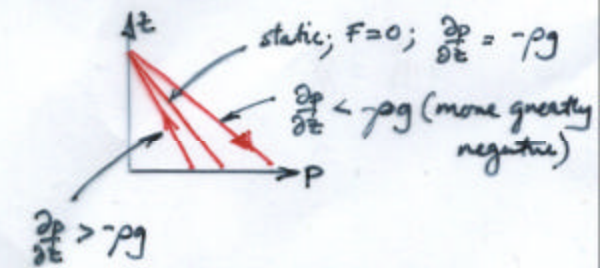
$$\left[\rho g \begin{Bmatrix} 0 \\ 0 \\ -1 \end{Bmatrix} - p \begin{Bmatrix} \partial/\partial x \\ \partial/\partial y \\ \partial/\partial z \end{Bmatrix}\right] dV = \underline{F}$$

equilibrium ⇒ $F = 0$

$$\frac{\partial p}{\partial z} = -\rho g$$

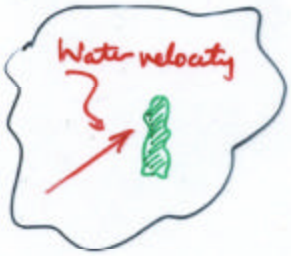
$\underline{F}$ is the resultant force vector. Force per unit volume.
Define the direction of force and ∴ direction of movement.

$F_z = 0$	$\partial p/\partial z = -\rho g$	static fluid
F_z = +ve	$\partial p/\partial z < -\rho g$	↑ flow
F_z = -ve	$\partial p/\partial z > -\rho g$	↓ flow



Also define lateral direction of flow.

3.6.2 NAPL and water



Will the gradient move the NAPL

Require to overcome capillary pressure, P_c

P_c acts uniformly in all directions and must be overcome

Need to know size of NAPL pocket.

P_c acts over length, L.

L is typically unknown