Any Questions?

Homework #4
- Assignment using your Earth Systems Today CD
- Check the web site for explanation
- Due by next Thursday

Ground water
- Water that occupies the voids in rocks below the soil layer
- Very Important Resource
Water Problems in Hawaii

- Droughts
- Not much ability to store rain water
- Most rain water runs off out into the ocean
- As development increases, the possibility of water shortages increases

Half of the water we use comes from groundwater

- > 90% of domestic water comes from groundwater
- We cannot really control replenishment of groundwater

Ground water

- Main source in Hawaii is rainfall
- Addition of new water to the groundwater storage system is called recharge
- If amount of groundwater removed from the system > recharge, groundwater resource will be completely depleted

- Only about 15-40% of all the rain that falls on the islands get into the groundwater system
- Same amount runs off
- Remainder evaporates
Porosity and Permeability

- Important properties of rocks that affect groundwater recharge
- Porosity = percent of pore space in a given rock or soil volume

Porosity is a measure of the amount of groundwater that can be stored

(a) Porous sandstone

(c) Fine-grained sandstone
Porosity and Permeability

- Permeability = measure of how easily water can move through a rock

Campus demo: cement relatively impermeable, soil relatively very permeable

Rains water collects on the cement; water that runs off onto the soil sinks into the ground

Volcanic rocks that form our islands are among the most porous and permeable rocks on earth

Rainwater gets into the rocks through surface cracks

`A`a clinker is very porous and permeable

Dense interiors of `a`a flows impermeable
Water Table is a surface that is free to move up and down.
Groundwater flows from high elevations to low elevations.

Ground water flow in Hawai`i:
- From mountains to the ocean
- Even though permeability is very high, flow rate is low -- few meters per day
- Driven by differences in elevation of groundwater (less than 0.2 m / km of flow)

Aquifer:
- A rock that has sufficient porosity and permeability to readily yield groundwater to wells
- Volcanic rocks among best on Earth
- Confined and Unconfined

Unconfined Aquifer:
- A rock whose upper surface is a water table that is free to fluctuate in response to changes in amount of groundwater
Confined Aquifer
- A rock confined above and below by an impermeable layer (aquiclude)

Pearl Harbor-Honolulu Aquifer
- Most important in the islands
- Confined with artesian flow in low elevations
Ground water in Hawai`i

- Volcanic rocks are porous and permeable to great depths
- Seawater saturates the pore spaces
- Fresh water is less dense than seawater, so the fresh water floats on the seawater

Island with no rainfall

Island after lots of rain
Ghyben-Herzberg Lens

Potential Groundwater Problems

- Depletion of groundwater supplies
- Deterioration of groundwater quality
Potential Groundwater Problems

- Rain concentrated in mountains
- Rain not evenly distributed in space or time
- Concentrated in mountains; some years wet, some dry
- No large reservoirs

Sustainable Yield

- Amount of groundwater that can be removed from an aquifer without degrading (depleting) it

Questions?
Next Time
- Web Exercise – check web page
- No class

Next Thursday
- Read Chapter 6

Big Island Field Trip
- Remember the meeting tomorrow at 12:30 pm