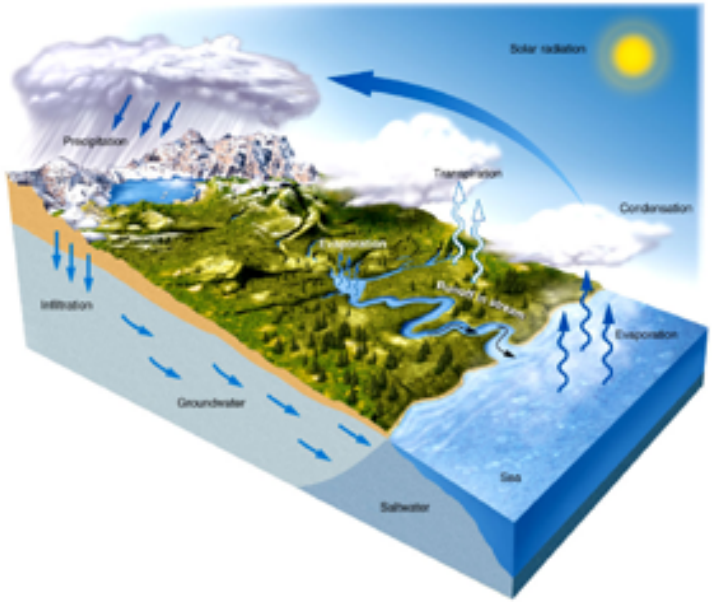
Ground Water

APES: 13-1, 20-3, 20-4
Environmental: 10

Borrowed from CSUS Geology Department

Ground Water

- *Ground Water* lies beneath the ground surface, filling pores in sediments and sedimentary rocks and fractures in other rock types
- Represents *0.6%* of the hydrosphere (35x the water in all lakes and rivers combined)
  - Resupplied by slow *infiltration of precipitation*
  - Generally cleaner than surface water
  - Accessed by *wells*

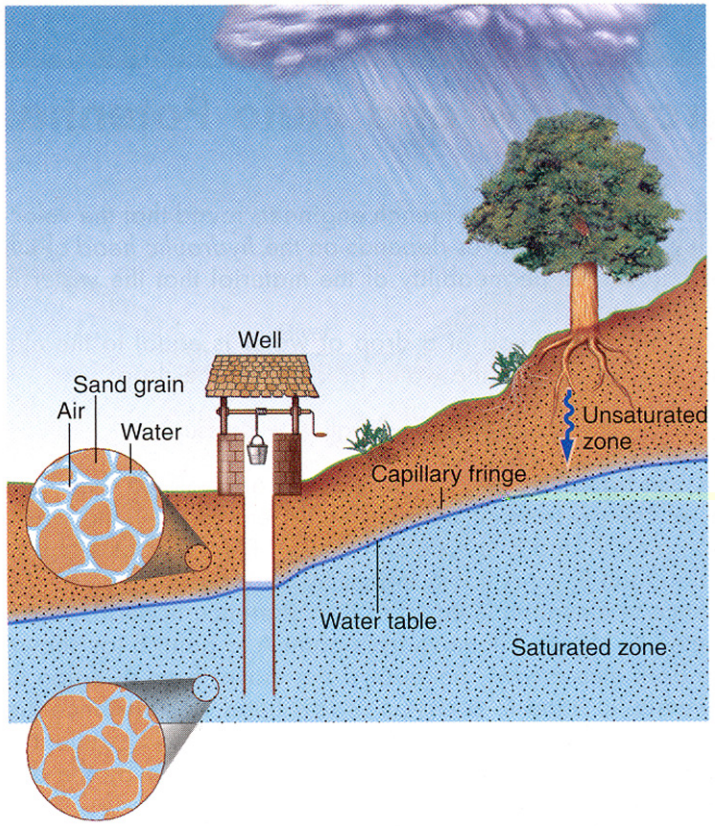


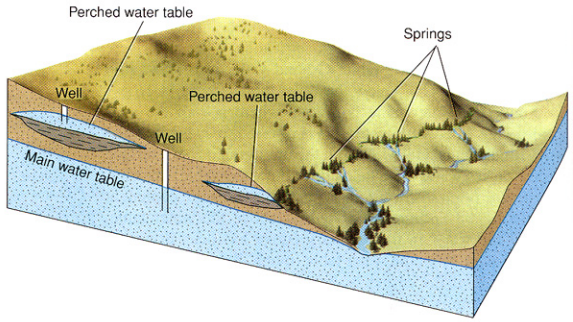
Porosity and Permeability

- *Porosity* - the percentage of rock or sediment that consists of voids or openings
  - Measurement of a rock's ability to hold water
  - Loose sand has ~30-50% porosity
  - Compacted sandstone may have only 10-20% porosity
- *Permeability* - the capacity of a rock to transmit fluid through pores and fractures
  - Interconnectedness of pore spaces
  - Most sandstones and conglomerates are porous *and* permeable
  - Granites, schists, unfractured limestones are *impermeable*

The Water Table

- Subsurface zone in which all rock openings are filled with water is the *phreatic, or saturated zone*
- Top of the saturated zone is the *water table*
  - Water level at surface of most lakes and rivers corresponds to local water table
- Above the water table is an *unsaturated* region called the *vadose zone*
- A *perched water table* is above and separated from main water table by an unsaturated zone
  - Commonly produced by thin lenses of impermeable rock (e.g., shales or clays) within permeable ones

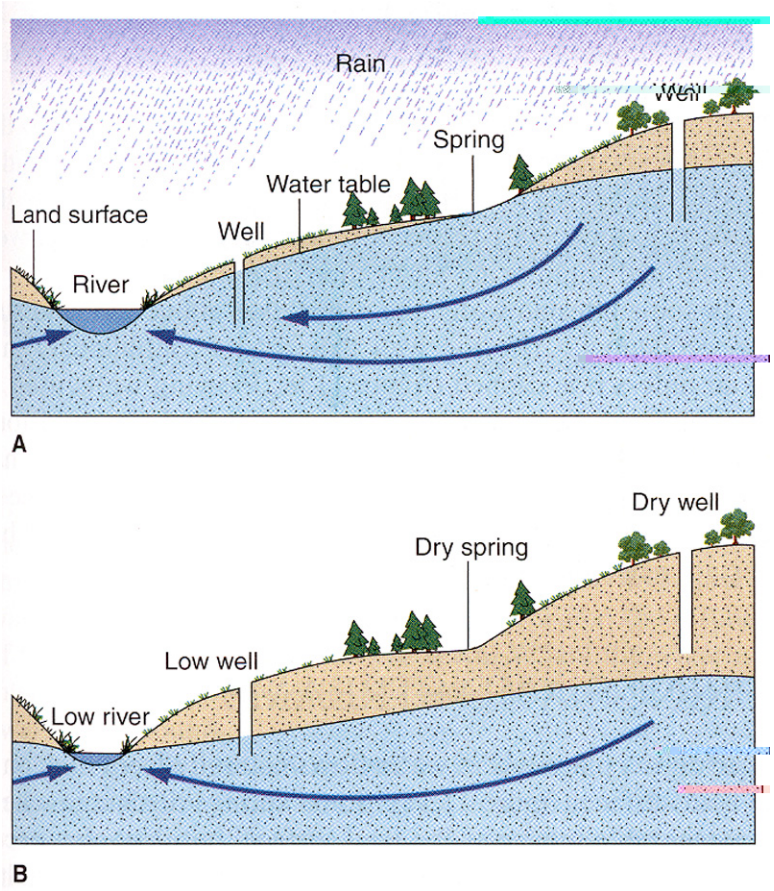




Ground Water Movement

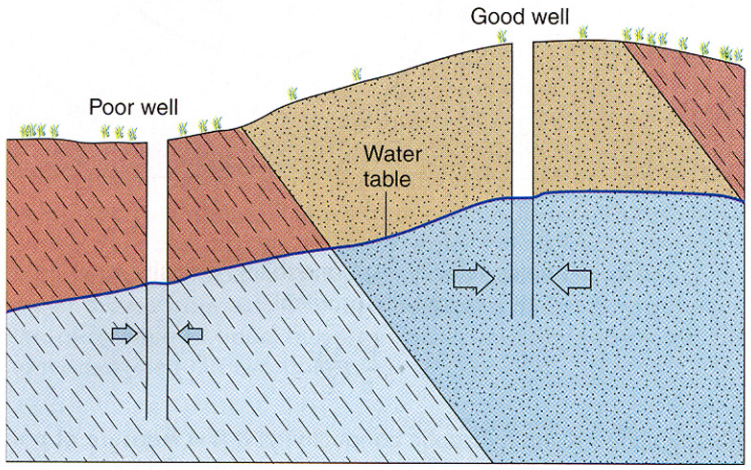
- Movement of ground water through pores and fractures is *relatively slow* (cms to meters/day) compared to flow of water in surface streams
  - Flow velocities in cavernous limestones can be much higher (kms/day)

- Flow velocity depends upon:
  - *Slope* of the water table
  - *Permeability* of the rock or sediment



Aquifers and Aquitards

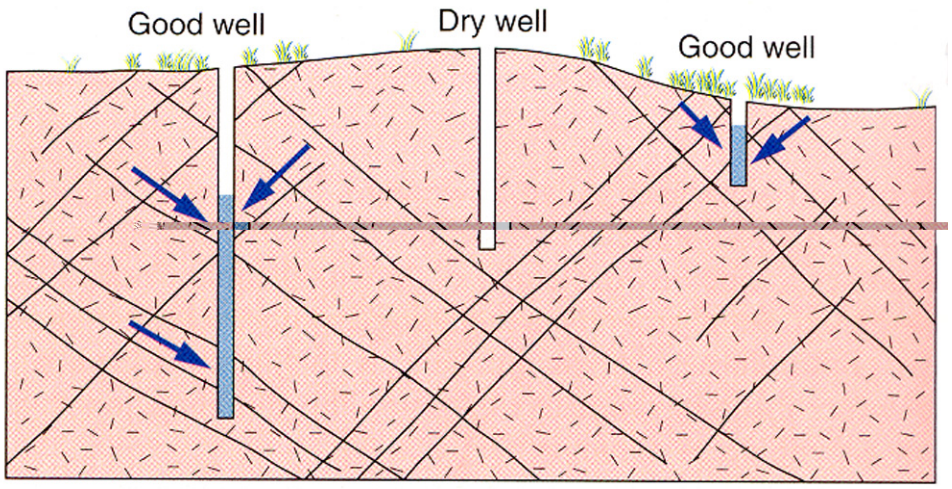
- *Aquifer* - body of saturated rock or sediment through which water can move easily
  - Sandstone
  - Conglomerate
  - Well-jointed limestone
  - Sand and gravel
  - Highly fractured volcanic rock



- *Aquitard* - rock/sediment that retards ground water flow due to low porosity and/or permeability
  - Shale, clay, unfractured crystalline rocks

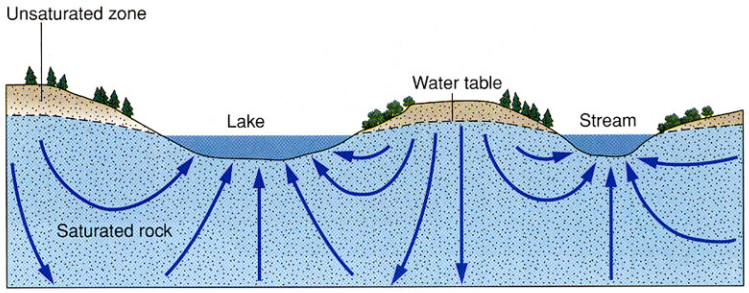
Aquifers

- *Aquifer*
  - Forms in fractured igneous rock (granitic)
  - Porosity and permeability are low
  - Wells are difficult to locate, yield is low
  - Often limits development

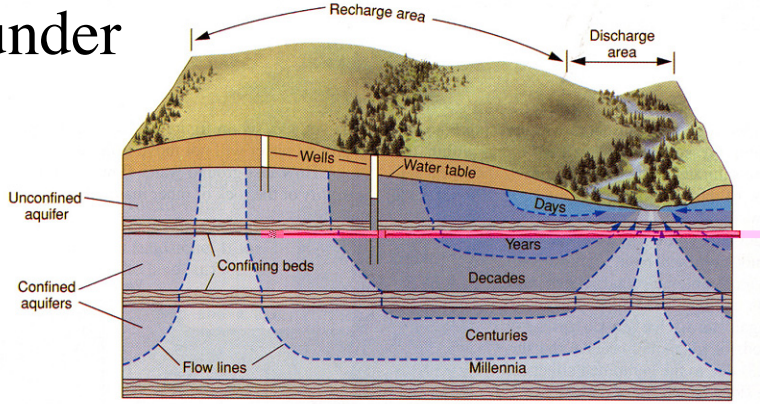


Unconfined vs. Confined Aquifers

- *Unconfined Aquifer*
  - Has a water table, and is only partly filled with water
  - Rapidly *recharged* by precipitation infiltrating down to the saturated zone

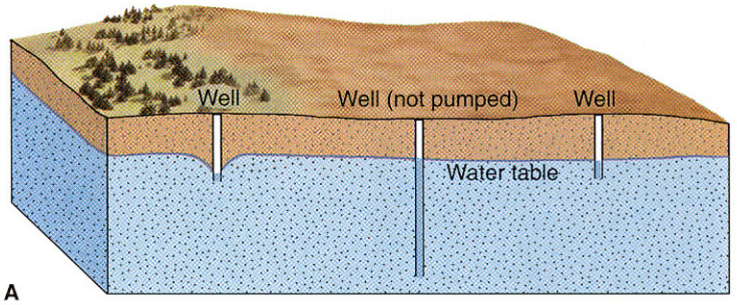


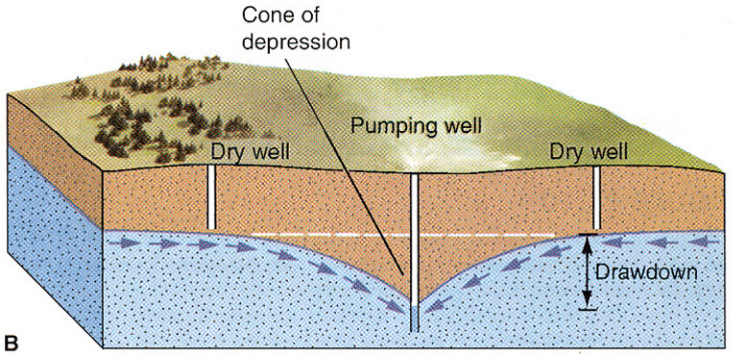
- *Confined Aquifer*
  - Completely filled with water under pressure (*hydrostatic head*)
  - Separated from surface by impermeable *confining layer/aquitard*
  - *Very slowly* recharged

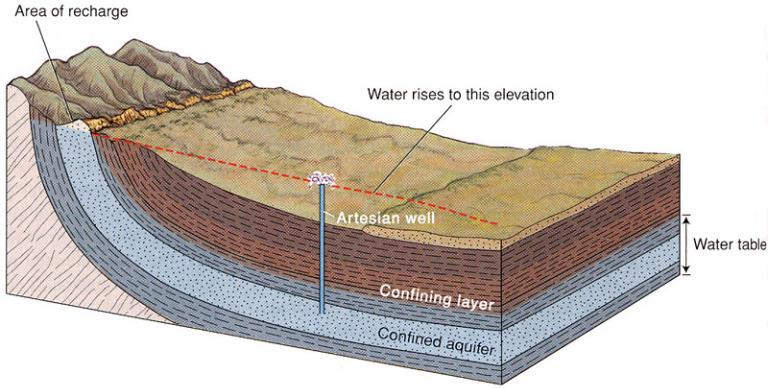


Wells

- *Well* - a deep hole dug or drilled into the ground to obtain water from an aquifer
  - For wells in unconfined aquifers, water level before pumping is the water table
  - Water table can be lowered by pumping, a process known as *drawdown*
  - Water may rise to a level above the top of a confined aquifer, producing an *artesian well*

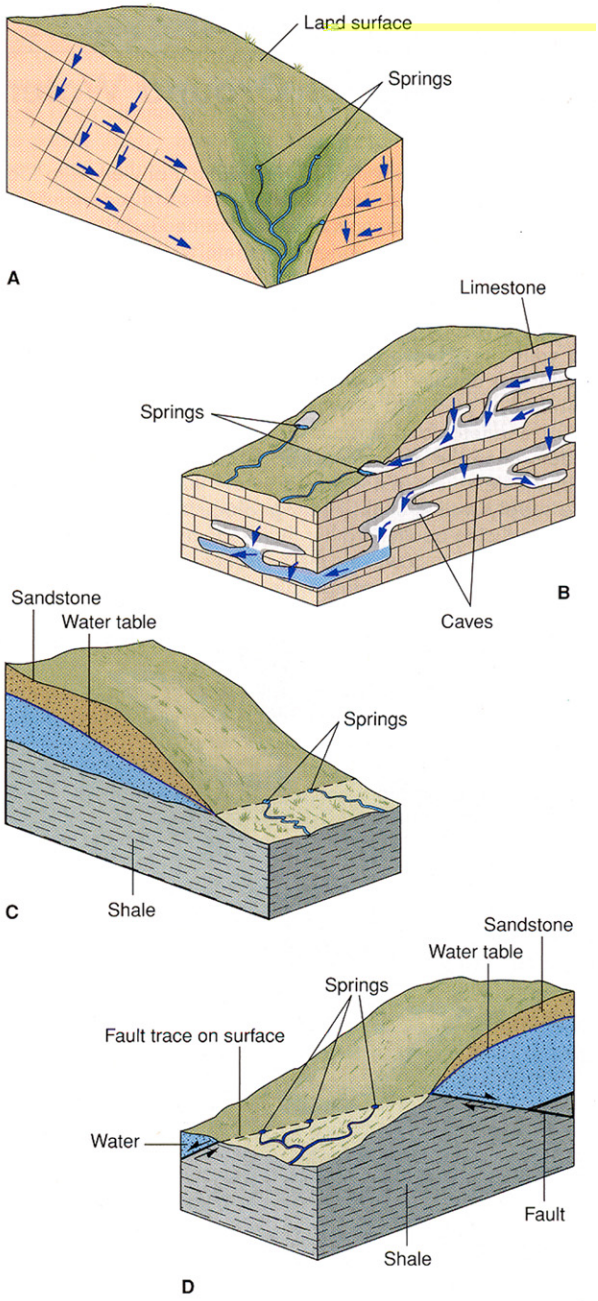






Springs

- *Spring* - a place where water flows naturally from rock or sediment onto the ground surface
- Closest natural spring to us, is Weeki Wachee
  - It's 72 degrees year round.



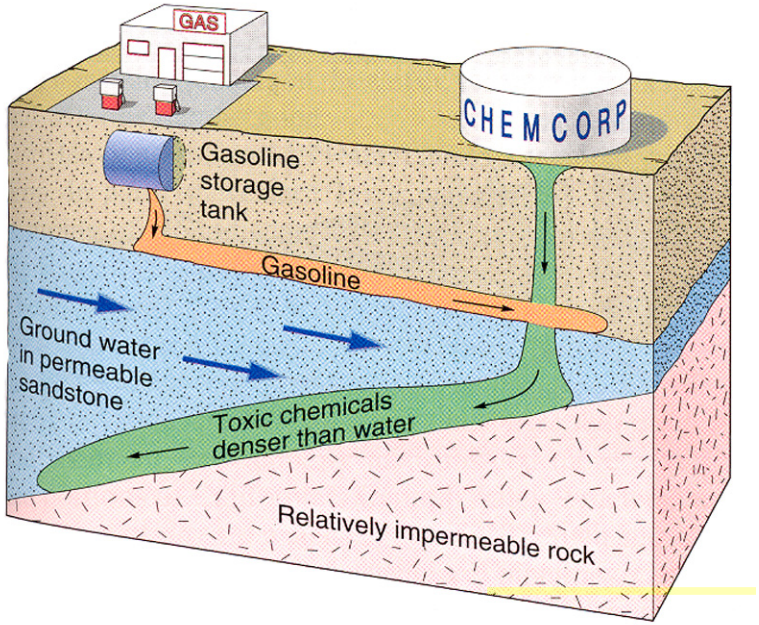
Ground Water Contamination

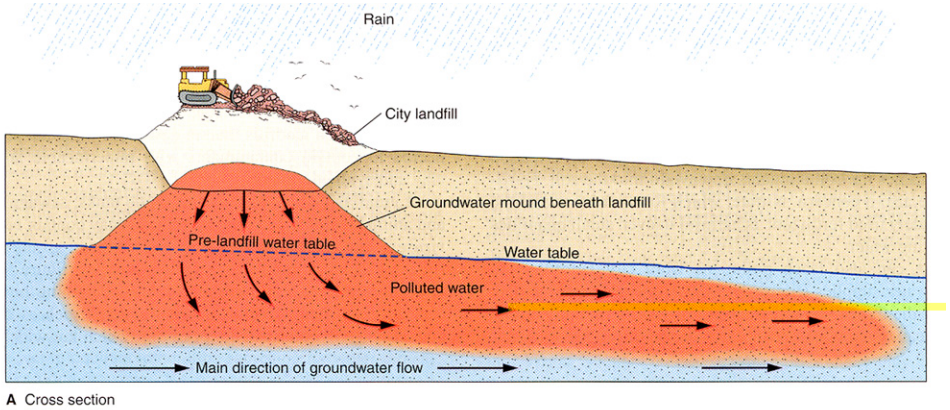
Infiltrating water may bring contaminants down to the *water table*, including (but not limited to):

- Pharmaceuticals
- Pesticides/herbicides
- Fertilizers
- Feed lots
- Mercury and gold mining
- Landfill pollutants
- Heavy metals
- Bacteria, viruses and parasites from sewage
- Industrial chemicals (PCBs, TCE)
- Acid mine drainage
- Radioactive waste
- Oil and gasoline

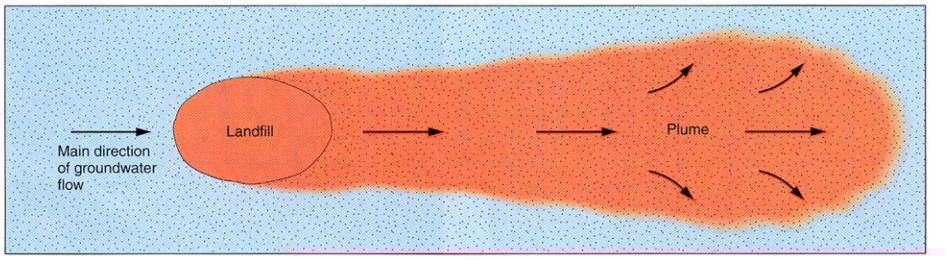
Ground Water Contamination

- *Contaminated ground water* can be *extremely difficult and expensive* to clean up





A Cross section



Florida Aquifer

- HB1149
- The state Legislature has decided to allow companies to dump "treated" sewage into drinking-water sources.
- Environmentalists say dumping a bunch of human-created chemicals into the water supply could permanently screw up an irreplaceable natural resource.
- What are your thoughts?
- If you were to write Tallahassee, what would you say?

Florida Algae Crisis

- Questions have been arising over whether Big Sugar is dumping into Lake O.
- Could be the reason for the green sludge we saw this fall !?!
- Maybe it is caused from something else !?!
- Extra Credit will be given for those who
  - Research the topic
  - Create a presentation for class on their findings

Assignment: due Friday

- **Pick your favorite groundwater contaminant**
  - Write a 1 page (maximum) paper that describes the following:

  1) Name of the contaminant, chemical formula

  2) How it affects people- when/where is it a problem to the human body, what are the harmful effects?

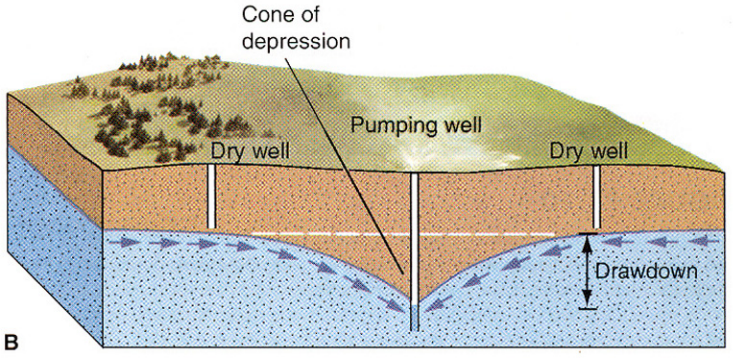
  3) Where it is found, how is it transported, how does it get into the groundwater system?

  4) What can be done to solve the problem?

  Due date: beginning of class, Friday

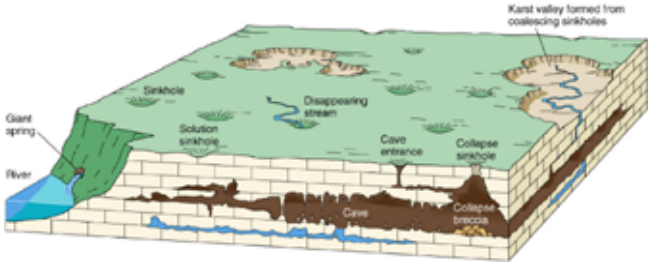
Balancing Withdrawal and Recharge

- If ground water is withdrawn more rapidly than it is recharged, the *water table* will drop
  - Dropping water table can lead to ground *subsidence*
    - surface of the ground drops as buoyancy from ground water is removed, allowing rock or sediment to compact and sink
  - Subsidence can crack foundations, roads and pipelines
  - Areas of extremely high *ground water pumping* (such as for crop irrigation in dry regions) have subsided 7-9 meters



Caves, Sinkholes, and Karst

- *Caves* - naturally-formed underground chambers
  - Acidic ground water dissolves limestone along joints and bedding planes
- Caves near the surface may collapse and produce *sinkholes*
- Rolling hills, disappearing streams, and sinkholes are common in areas with *karst topography*



Hot Water Underground

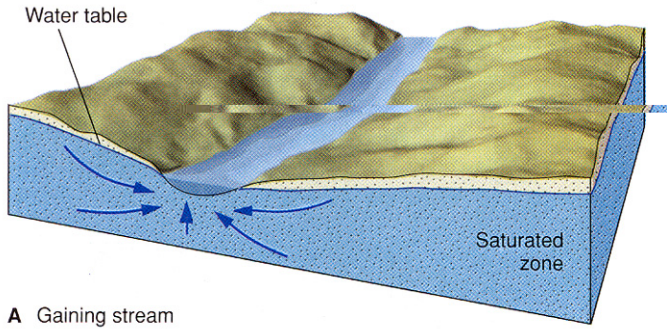
- *Hot springs* - springs in which the water is warmer than human body temperature
  - Ground water heated by nearby magma bodies or circulation to unusually deep (and warm) levels within the crust
  - Hot water is less dense than cool water and thus rises back to the surface on its own
- *Geysers* - hot springs that periodically erupt hot water and steam
  - Minerals often precipitate around geysers as hot water cools rapidly in the air

Geothermal Energy

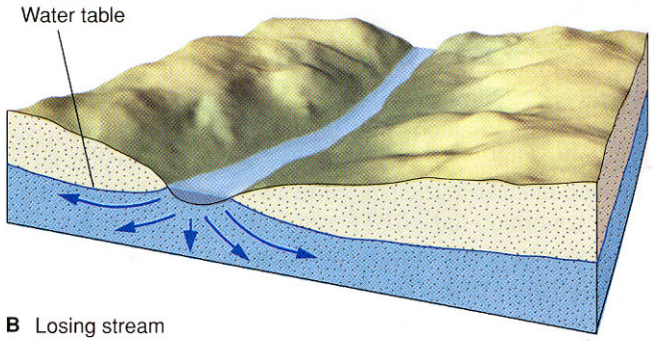
- *Geothermal energy* is produced using natural steam or superheated water
  - No CO_2 or acid rain are produced (*clean* energy source)
  - Some toxic gases given off (e.g., sulfur compounds)
  - Can be used directly to heat buildings
  - Superheated water can be very corrosive to pipes and equipment

Streams and Groundwater

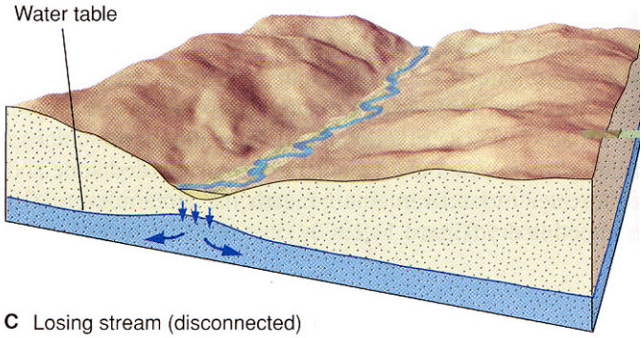
- *Gaining streams* - receive water from the saturated zone
  - Gaining stream surface is local water table
- *Losing streams* - lose water to the saturated zone
  - Stream beds lie above the water table
  - Maximum *infiltration* occurs through streambed, producing permanent "mound" in the water table beneath dry channel



A Gaining stream



B Losing stream



C Losing stream (disconnected)