Ch.11-Ground Water
Ground Water- lies beneath the ground surfaces filling the pore space between grains in bodies of sediment and elastic sedimentary rock, and filling cracks and crevices in all types of rock>major economic resource, especially in dry western U.S.
Approximately 15% of the total precipitation ends up as groundwater (does vary from1% -20%).

Porosity- the percentage of rock or sediment that consists of voids or openings
>measurements of a rock's ability to hold water
>most rocks can hold water
>Table 11.1- compaction/cementation lowers porosity

Permeability- refers to the capacity of a rock to transmit a fluid through pores and fractions.
- measures the relative ease of water flow and indicates the degree to which openings in a rock interconnect.

THE WATER TABLE
>Responding to the pull of gravity, water percolates down into the ground through the soil and through cracks and pores in the rock.

Water Table Zones
Saturated Zone- subsurface zone in which all rock openings are filled with water.

Figure 11.1- Water Table- upper surface of saturated zone.

Vadose Zone- a generally unsaturated zone above the water table.
>surface tension causes water to be held above the water table (the capillary fringe).
>Plants like moisture and air space of vadose zone.

Perched Water Table-top of a body of ground water seperated from the main water table beneath it by a zone that is not saturated. (Fig. 11.2)

THE MOVEMENT OF GROUND WATER
In general, water moves in response to differences in water pressure and elevation.

Darcy's Law and Fluid Potential
Hydraulic Head = elevation + pressure.
Hydraulic Gradient = difference in head/distance=h/L

Law = Velocity =(Perm/Porosity) ((hydraulic gradient)
$V= K/n\ h/L$

Fluid Potential = g x hydraulic head Figure Z- Black Lines (potential) –Blue = flow

Facts:
The slope of a water table strongly influences groundwater- velocity.

>the steeper the slope, the faster the water moves.

Velocity also depends on permeability of the rock.
>dye traces

Figure 11.3- Movement of GW

AQUIFERS
Aquifer- body of saturated rock or sediment through which water can move easily.
- To obtain the water – must drill well- Fig. 11.4, 11.5
- Good aquifers: SS< conglomerate, well jointed Ls, sand and gravel, some fragmented or fractured crystalline rocks.

Aquitards- retard flow of water
- shale most crystalline rock

Figure 11.6 > Continued vs. Uncontinued Aquifers
Filled with H2o under P: Recharged by Precip. Rapidly
Slow water movement:

WELLS
Well- deep hole designed to penetrate aquifer.

Addition of new water to saturated zone- Recharge

Cone of Depression- occurs when water is pumped from well.
>Lowering of W.T.- Drawdown
>Drawdown does not occur with light use.

Continued Aquifers can sometimes produce artesian condition (sometimes called Artesian Wells/AQ).
>water rises above the top of the aquifer Dakota SS
(Fig. 11.6 then Fig. 11.9) - Fig 11.11

Figure 11.12- along fractures, faults or rock contacts.

Gaining streams- receive water from the saturated zone.
Fig. 11.13
Losing Streams – lose water to saturated zone.

CONTAMINATION OF GROUND WATER
Pollutants: Pesticides, herbicides, fertilizers (nitrate), heavy metals
Fig. 11.14- yuck
Sewage (virus, bacteria, parasites)
Cyanide, degreasers, acid mine drainage, radioactive waste

Yucca Mtn.- 180 miles NW of Vegas
Contaminants (cont.)
1) Less dense spread out (gas) – Fig. 11.15
2) More dense sink – Fig. 11.16

Not all contaminants are man –made.
- Naturally occurring- As, Se, Hg.

Sometimes aquifers can purify themselves
Sandy Loam vs. Fractured Rock Fig. 11.17

Groundwater wells are difficult to clean up.
- Pumping can contaminate (Fig. 11.18)

Balancing Withdrawal and Recharge
Sinking Cities- Houston, Mexico City (7m), San Joaquin Valley (9m)
>subsidence can damage buildings.

EFFECTS of GROUNDWATER ACTION

Caves, Sinkholes, Karst Topography
Figures 11.19-11.23

Other Effects: Petrification, Concretions, Geodes

Hot Springs- Warmer the human body T.
-Geysers
Geothermal Energy.