Announcements:
Labs start this week in the Geology building.

Ch. 1 Building a Planet

Earth	Venus
- 78% Nitrogen	- 99% Carbon Dioxide
- 21% Oxygen	- similar size and density to Earth
- .035% Carbon Dioxide	- 90 times the atmospheric pressure and sulfuric acid clouds
	- hot surface

Earth used to have much more carbon dioxide, but it is now contained in organisms, limestone, coal, etc.

*See figure 1.5 in the book on page 9.

Early life: Blue green algae which is over 3 billion years old and they form colonies called stromatolites.

A differentiated planet (see figure 1.6 in book on page 10)
- during period of early partial melting the rocky inner planets differentiated into three layers of different chemical and physical compositions.
- core (inner and outer)- metallic
- mantle- rocky, intermediate density
- crust- rocky, low density

Ch. 2 Minerals

Quartz (see picture on page 24)
Gem- Amethyst
Structure- Hexagonal
Composition- silicon and oxygen
Other- There is a trace of Al which gives it its color purple and it becomes amethyst.

Composition of the Earth (see figure 1.7 on page 10)

Most minerals talked about in this course are silicates, containing silicon and oxygen.

Review:

- structure of an atom (see figure 2.2 on page 27)
- periodic table (see figure 2.6 on page 31)
- ionic and covalent bonding

Identity of atoms is by the number of protons.

- usually carbon is carbon 12, 6 electrons and 6 protons, which is organic
- carbon 13, which is inorganic, and carbon 14, which is radioactive and used for dating, are more rare than carbon 12

Electron sharing: covalent bonding, i.e. diamond with a tetrahedron structure

- graphite: same composition as diamond, but it is a different mineral because of arrangement of bonds
- metallic bonds: bond which has a free sharing of electrons

Silicate minerals:

- silicon and oxygen make up most rocks
- 45% of whole earth
- 75% of crust
- are called silicates
- strong covalent bonds
- great material strength
- difficult to weather

Structure of silicates (see figure 2.17 on page 39)

- Isolated silicate tetrahedral: simplest silicate structure, heavy, lots of metal cations
- Chain silicates: long, rod-like minerals, single chain (pyroxene), double chain (amphibole)
- Sheet silicates: sheet like minerals including micas and many clays
- Framework silicates (tectosilicates): 3-D lattice works of linked silica ions, includes quartz and feldspar

Non- silicate minerals:

- salts, oxides, sulfates, sulfides, carbonates

Important mineral classes:

- carbonates: 1/5 of the world's sedimentary rocks
- oxides: major ores
- sulfides: major ores

*Be sure to read end of chapter 2.

Review or mineral properties (see table 2.4 on page 46)

- Mohs scale of hardness, see table 2.2 and memorize it
- Cleavage: breakage along planes

Ch. 3 Rocks: Records of Geologic Processes

Three groups of rocks:
- igneous: formed from molten rock
- metamorphic: mineral changed from heat and pressure
- sedimentary: deposited and lithifies when buried

Igneous:
- Granite- course grain, intrusive, time to grow
- Rhyolite- fine grain, extrusive, cooled fast, grain didn't have time to develop

Magma- molten rock
Extrusive- magma that erupts on surface cooling quickly
Intrusive- magma that remains buried and cools

Sedimentary:
- sediment becomes rock through lithification either burial and compaction or through cementation
- sediments are often layered

stratification- layering of rock
bedding- layered arrangement of strata in a sedimentary rock
bedding surface- the top or bottom surface of a rock layer

2 kinds of sedimentary rocks:
- clastic- made up of particles from other rocks such as sandstone, conglomerate, and shale
- chemical and biochemical- limestone, minerals formed by an organism

evaporates- formed by the evaporation of seawater or lakewater
limestone- a biogenic or bioclastic rock typically formed in the ocean and made of calcite
coquina limestone, gypsum and limestone

rocks differ with respect to grain size, sorting, and rounding, which tell us about the processes active when the sediment was transported and deposited
- grain size- fast water transports large grain, slow water transports light grains

Banded Iron Formation: Chemical Sedimentary Rocks

A finely lamented chemical sediment typically containing 15% or more of iron and abundant silica iron oxides include both hematite and magnetite

*see figure 3.4 on page 57

Metamorphic rocks form by solid state changes due to temperature, pressure, stress and fluid

Forming Metamorphic Rocks

- regional metamorphism- deeply buried rocks that deform like modeling clay over millions of years
- contact metamorphic- cooled rocks around cooling magma

orogonies- mountain building events

*see table 3.10 on page 61

There was a pop quiz at the end of class.

Plate Tectonics:
- plates of rock float on the mantle (they're less dense) and more about the earth to distribute heat

Plate Margins:
- divergent- pull apart
- convergent- come together
- transform- they slide apart

Alfred Wegener- continental drift

Plate motion is conservative, all relative plate motions add to zero

All oceanic crust forms at mid-ocean ridges, which are the most common divergent plate boundary and mid-atlantic ridge (slow spreading, 1-2 cm/year) and East Pacific Rise (fast spreading 10-12 cm/year).

Divergent:
- triple junctions- places where three different plates come together

Convergent:
- compression- subduction zones, one plate slides under the other, makes volcanic arcs
- ocean trenches- Peru-Chile Trench, Marianas Trench
- ocean/ continent collision= Andes Mountains
- continent/ continent collision= Himalayan Mountains

Transform:
- plate boundaries with very little compression or extension
- San Andreas Fault
- Dead Sea

Hot Spots:
- Hawaii, volcanoes

Pangea- most recent supercontinent

Ch 4 Igneous Rocks

Properties:
- formed from solidification of molten rock
- they are columnal- cuts in columns

*see picture in book, table 4.1 on page 71

Extrusive Igneous Rocks:
- obsidian, volcanic glass, froze as glass, did not have time to separate in to minerals
- phenocrysts (large crystals) and fine-grained groundmass
- porphyritic texture
- vesicular basalt- fine-grained, no time for grains to develop

Intrusive Igneous Rocks:
- granite- can see individual coarse grains, crystallized slowly in deep magma
- plutonic rock- igneous rock formed from magma that cooled

*see table 4.2 on page 74
Major Element Changes From Igneous Rock
- basaltic melts only in high temperatures
- felsic melts in lower temperatures

Silica content of magma (volcanic rock)
- basalt- mafic rock, 45-50% SiO_2
- andesite- intermediate, 60% SiO_2
- rhyolite- felsic rock, 70-75% SiO_2
- melting temp. drops as SiO_2 level rises

Volcanic and Plutonic Equivalent
Mafic:
- gabbro- coarse grained, solidified in depth
- basalt- fine-grained
- both 40-45% SiO_2

Intermediate:
- diorite- coarse grained
- andesite- fine grained
- both 60% SiO_2

Felsic:
- granite- coarse grained
- rhyolite- fine grained
- both 70-75% SiO_2

Taking Volcano's Temperature:
- molten rocks is incandescent- glows, color related to temperature
- bright yellow (basaltic lava) is hotter than red and black lava (felsic lava)

Geothermal Gradient
- pressure increases with depth
- although temperature increases with depth, pressure weighs out and makes the mantle solid

Albar- (Na Feldspar)
- melts at much lower temperature when with water

Fractional Crystallization- process by which crystals and liquid separate from one another during crystallization and cooling which leads to:
- magmatic defferentiation- formation of different compositions of rock from a single magma

*see table 4.11 on page 81 for Bowen's Reaction Series

Announcements:
- pop quiz in lecture

batholith- a large pluton, irregular masses of coarse-grained igneous rock at least 1 km square
stock- other plutons, smaller than batholiths
dike- major route of magma transport in the crust
sill- tabular sheet like body that was formed by the injection of magma between parallel layes of existing rock

Igneous Rock, along volcanic areas
- magma composition changes rock outcome

Volcanos:
- viscosity
- mafic, basaltic lavas have low viscosity
- Aa lava- poor in volatiles, very viscous
- Pahoehoe lava- very volatile rich and fluid

Kinds of Volcanos:
- shields- safer, wider
- composites- not as wide, dangerous, high, steep sides (stratovolcano)

Flood Basalts- hardened magma from volcanic eruptions

Explosive Eruptions:
- strombolian- mild eruption
- bomb- large
- lapilli- a few mm
- ash- less than 1 mm
- nuee curdent (glowing cloud)
    - very destructive
    - pyroclastic flows
- Plinian eruptions- blew vertically and laterally
- Caldera eruption- circular depressions formed when the top of a volcano collapses into an empty magma chamber

Geysers:

- thermal springs with a natural plumbing that causes intermittent eruptions of water and steam
- water heated by rocks below

Volcanic Hazards:
- lava
- ash
- poison gasses
- landslides

Weathering- a breakdown of rocks into other parts

Erosion- taking pieces from original place to deposition place

Regolith- broken rock, lacks inorganic material

Mechanical Weathering: physical breaking of rocks into smaller particles
- ice wedging- water gets into cracks, freezes, expands, arctic climates, temperate climates, and high altitudes
- root action- roots force rocks apart
- wind action- carries sand and sandblasts rock faces
- exfoliaiton- large thin sheets of rock that fall off, related to shrinking and contraction during uplift of rocks, makes spherical rocks
- landslides- rock avalanches, large volumes of rocks that move over Earth's surface like liquid
- water action- rivers cut into rock and remove regolith, abrasion, sheer force, landslides, water fracturing
- glaciers- permanent ice that flows slowly due to gravity, ice scrapes and plucks rocks creating sediment volumes
- weak parts of rocks which have joints or cracks get weathered first

Chemical Weathering: atoms are released from rocks by chemical activity
- most important kind of erosion for most of Earth
- aids mechanical weathering
- weakly acid rainfall
- oxidation from air
- dissolution
    - acids dissolve rocks
    - creates karst and sinkholes in carbonate rocks
- hydrolysis
    - weak acids strip cations out of minerals
    - main process of: weathering silicates and making clay
    - needs water to occur
    - living organisms make acid and increase amount of hydrolysis
- oxidation- same as rusting, adds oxygen to molecules

Soil Profile:
- organic
- weathered/ oxidized
- more regalith

Bowen's Reaction Series

Order of crystallization:
- olivine
- pyroxene
- amphibole
- biotite mica
- orthoclase
- feldspar

Soil:
Lateries- intense chemical weathering, little left but aluminum oxide and iron oxide
Pedalfers and Pedocal

Sedimentary Rocks:
- layered rocks
- sedimentary rocks, weathered, transported, deposited

Erosion:
- mass wasting- downslope movement of regolith and/or bedrock due to the pull of gravity
- the ability of a fluid to pick up and move material depends on its velocity and turbulence

saltation- bouncing of sediments along surface
bed load- process of saltation
suspended load- cannot dissolve
dissolved load- completely dissolved
-Erosion by wind- sorts particles by grain size
-Sediments:
- Composition
  - Fragments of rock- clastic
  - Chemical
- Texture
  - Grain size
  - Sorting
  - Roundness
  - Packing
- Structure- how well the sediment was deposited

*see table 1 in Ch7 for sediment composition

Depositional Environments:
- beach- quartz sand, dominated by wave action and oscillatory current flow
- river- dominated by unidirectional current flow
- delta- where river enters larger body of water, speed of water slows, cannot carry as much sediment so it deposits it
- lake- deposits suspended load, quiet water, fine-grained sediment
- glaciers- little sorting by particle size, angular, coarse grained sediments
- deserts- well sorted, fine grained sand and silt
- deep sea turbidites- made of graded beds, no trace fossils

Creating Sedimentary Basins:
- rift- breaking of land at divergent boundaries
- petroleum- fossil fuel, sedimentary rocks
- coal- #1 energy source, fossilized organic material, carbon

Metamorphic Rocks:
Metamorphism- solid state changes in a rock due to the effects of pressure, temperature, or chemical change
- regional metamorphism- mountain building events
- contact metamorphism- cooling plutons
- migmatite- a metamorphic rock that has started to melt

uniform stress- same force from every direction
differential stress- more force from one direction than another, align perpendicular to pressure
foliation- planar alignment of metamorphic minerals (especially micas) with mineral alignment perpendicular to the highest stress direction

Metamorphic textures: cleavage vs. bedding

Uniform stress- no foliation, without platy materials, ie. Limestone metamorphised

Announcements:
Test on ch 1-9 and 20, on Friday

Metamorphism happens faster with water.
- leaves quartz veins
- transports trace elements

Contact Metamorphism- high temperatures, lower pressure
Subduction Zones- low temperatures, higher pressure
Underneath Mountains- proportionate temperature and pressure

See table 8.2 Minerals Depend on Composition

Relative Age: ch 8 and 9
- strata- individual layers of sediments and sedimentary rock
- stratigraphy- the study of strata and stratafication
- relative age- whether a rock is older or younger than another rock

Principle of original horizontality- water borne sediments are deposited in horizontal strata
Principle of Superposition- top layers of rock are younger than the bottom layers
Principle of Cross-Cutting Relationship- a rock unit must always be older than any feature that cuts or disrupts it

Types of Unconformitites:
- angular unconformity- an erosion surface or missing time between strata dipping at different angles
- disconformity- missing time between two sets of parallel strata

Announcements:
- Exam results are posted on the class website. The average score on the exam was a 40.

Ch 9- The Rock Record

Review from last week: relative age and the three principles.

Unconformities- gaps in time record of deposition
- angular
- disconformity

The Geologic Time Scale, *see picture in book

Major Eons:
- Phanerzoic- good fossil records
- Proterozeric- evidence of oxygen, plate tectonics, about 2.5 billion years ago
- Archean- have rocks, from 4-2.5 billion years ago
- Hadean- no rocks, 4.6-4 billion years ago

Phanerzoic Eras: indicate times of mass extinction revealed in the fossil record
- Cenozoic- mammals, began with mass extinction
  - Pleistocene- 2 million years ago
  - Holocine- end of last ice age, began 10,000 years ago, present age
- Mesozoic- dinosaurs, began with mass extinction
  - Cretaceous
  - Jurassic
  - Triassic
- Paleozoic- fish, tribolites

Class website: http://www.bsos.umd.edu:8090/~gvpt100
Things to know for test:

1. Rule by law
2. law and discretion- always be necessary
3. common and civil law system

Differences Between Common and Civil Law System:

1. judicial decisions are law
2. juries
3. adversarial system

Legal Hierarchy

- legislature fails to prepare for new situations
- fact finding

common law- facts decided by jurors

civil law- conflicts between people, statutes are sources of law, no juries, reliance on inquisitorial

judicial decisions are sources of law

juries decide facts and trials involve adversarial system

Adversarial System vs. Inquisitorial System:

- in adversarial, judge is passive, jury decides cases
- in inquisitorial, judge orders witnesses and asks questions
- adversarial system, decisions made entirely on what is presented

Common Law Jury:

1. juries are now people who don't know
2. juries used to be to show dislike of laws, not whether people were guilty- jury nullification- in theory jury only finds facts
3. juries were final, word on not guilty is final unless can show reasonable jury would never rule that way
   - present evidence that says didn't do it, jury convicts, judge can overturn
   - only appeal judges rulings of law- not way jury decided facts
4. judicial decisions in common law are sources of law
   - common law- court must explain decision
   - civil law- similar cases start over despite previous similar decisions

Announcements:
- short lecture today
- test scores on web
- need to sign up for field trip to Great Falls if want to go

Strike- slip faults- horizontal displacement, breaking rocks in shear, shallow
Reverse fault- breaking rock in compression, allow crust to shorten and thicken, deep

Joints cracks from shrinking rock or uplifting of rocks

Ductile Deformation: Folds
- monocline- a change in the dip of a sequence of strata (perhaps caused by a fault at greater depth
- simple folds:
  - syncline- a down fold, concave upward
  - anticline- an up fold, convex upward
- asymmetric folds:
  - symmetrical
  - asymmetrical
  - overturned
- plunging folds:
  - plunging anticline
  - plunging syncline
- dome- upwarding from folding in two directions, older in center
- basin- downwarding from folding in two directions, younger in center

Topographic Contours:
- topographic map- map that uses contour lines to show the shape and relief of ground surface
- contour lines- lines of equal elevation
- relief- difference between the highest and lowest elevations
- contour interval- vertical difference in elevation between the contour lines
- closely packed lines imply a steep slope constructing a topographic profile from a map: a cross section of the surface elevation along a line

Fossils and Correlation:
- fossil- remains of plants and animals incorporated in sediments when they were deposited
- paleontology- the study of ancient life
- faunal succession- striigraphic ordering of fossil assemblages (William Smith) which was the basis of worldwide correlation
- acasta gneiss- oldest rocks, over 4.1 billion years

Atmosphere:
- present- nitrogen and oxygen
- then- nitrogen and carbon dioxide
- most of the carbon dioxide was lost because of animals and plants
- photosynthesis- process by which plants utilize light energy to cause carbon dioxide to react with water producing carbohydrates and oxygen
- without oxygen, no ozone because of UV from sun

Single Cells:
- respiration- use of oxygen to oxide carbohydrates to create carbon dioxide and energy
- microfossil- fossil cannot be seen by the naked eye

Early Animals:
- 550-600 million years ago
- resemble jellyfish
- size limited because of oxygen
- Cambrian Explosion- macro-organisms spread over planet

Early Life on Land:

- algae
- needs
    - structural support
    - plumbing system
- ferns

Ancient Insects:

- anthropods- jointed legs
- crabs
- spiders
- centipedes
- insects

Announcements:
- quiz in class, answers on website

Hominid Evolution:
- evolved into mammals
- ice age in some areas
- climate change caused evolution

Human History:
- huge exponential evolution
- now ~6 billion people

Dating Hominid Fossils:
- preserved in sedimentary rocks
- different to date

Chapter 11- Mass Wasting

Mass wasting- sedimentary transport through the force of gravity
- large volumes move
- move quickly
- significant hazard to life, infrastructure and property

Angle of Repose- the angle at which a pile of something is stable
- water influences angle of repose
- when substance is steeper than its AOR, it will fall, which is mass wasting

Mass wasting triggers:
- add/trap water
- undercut material
- add material at top
- over steepen
- add energy (earthquake)
- remove plants (weakens)

Classification:

1. What falls?
    a. Rock
    b. debris
2. How does it move?
    a. Flows
    b. Slides
    c. Falls
3. How fast?
    a. Slow- can't see in short time
    b. Medium- slower than walk
    c. Fast- faster than walk

Scarpes and Toes
- landslides all have a head failure that produces a scarp
- displacement forms the toe

rock falls- isolated boulders fall

rock slide- whole hill of rock slides

avalanches- rocks move rapidly as granual fluids

rock avalanches and landslides also form in space, evidence of them on mars

creep- imperceptibly slow movement of regolith downhill

Freeze-Thaw Creep:

1. water saturation of pores
2. water freezes and expands lifting material perpendicular to slope
3. ice melts and gravity pulls materials down vertically
4. repeated cycles of freeze and thaw

Earthflows:

- typically fine-grained, these events flow slowly (cm/year), they tend to be very large, which can block roads and trains

Debris Flow:

- slurries of rock, sand and mud mixed with water
- common in steep areas and typically occur after heavy rain

alluvial fans- a rapid change in slope deposits the sediment in a pile on the floor

Mud Flows:

- like debris flows, but dominated by mud and clay
- with a lot of water, they can move quickly

Slumps:

- regolith slides
- cause lots of damage
- move very large volumes of sediment

Landslide Hazard:

- energy from earthquakes can destabilize rocky slopes, initiating large landslides
- no comprehensive landslide law

Landslide Mitigation:

- failures can start by-
  i. adding or trapping water
  ii. undercutting material
  iii. adding material at the top
  iv. oversteepening
  v. adding energy (earthquakes)
  vi. removing plants (weakens)
- failures can be prevented by-
  i. draining water
  ii. reinforce base of slope
  iii. remove material from top
  iv. shallow slope
  v. add plants (strengthens)

Chapter 12- Water On and Underground

Hydrologic Cycle-
- hydrosphere- part of the Earth system containing the oceans, lakes, groundwater, rivers, underground water and frozen water
- evaporation, precipitation, and runoff

Water Reservoirs-
- mostly oceans
- some ice, underground, lakes and rivers
- mostly salt water
- little in atmosphere and biosphere

Rain Shadow- when mountain range squeezes atmosphere of moisture

Wetlands as storage reservoirs for water
- dry period- low runoff
- wet period- high runoff

Porosity and Permeability-
- porosity- space between grains that store water- % of total volume of rock consisting of voids called pore spaces
- permeability- capacity of a rock to transmit fluids- it is a function of pore throat diameter
- hydrostatic pressure- means the same pressure of a column of water
- shale can be very impermeable

Underground Water-
- water table- top surface of saturated zone, under the aerated zone

Ground Water Flow- water flows downhill
- aquifer- a saturated, porous permeable formation
- recharge area- where infiltration of the aquifer occurs
- aquiclude/ aquitard- impermeable layers
- artesian aquifers- flows without pumping, because top is lower than recharge area

Springs- occur where an aquifer intersects the surface
- perched water table sits above an aquaclude that overlies another water table

Flow Rate in Aquafers-

- slope
- permeability

Subsurface flow defined by Darcy's Law

Example of Aquifers-
- Great Plains- low rainfall, no local recharge area
- Atlantic Coast- recharge area in mountains, more rain

Caves and Sinkholes- limestone, water infiltrated from surface and eats away at the limestone to form cave
- sinkhole- collapsed cave roof

Karst topography- Karst terrain- result of massive regional dissolution

Water in the Whole Crust
- water occurs in the entire crust
- burial reduces the water content of rocks
- in igneous and metamorphic rocks at great depth, water volume and permeability are low

Demands on Water Supply
- majority goes to irrigation
- industrial and public supply are not as much
- rural is very little
- total supply has grown greatly since 1950

Groundwater Depletion
- drawdown by excessive pumping can cause wells to go dry if they are within the cone of depression

Coastal Aquifers
- groundwater geometry underlays much of the Delmarva Peninsula, Florida and the rest of the Atlantic seaboard
- rapid pumping water can start coning from above and below, resulting in salt water intrusion

Groundwater Contamination
- contaminants introduced below the water table (within the aquifer) travel much faster than contaminants on the unsaturated zone
- contamination contained due to impermeable bedrock
- contamination moves along bedrock fractures into aquifer
- contamination goes directly into groundwater because of permeable, saturated strata

Leaking Underground Storage Tanks
- there are any jobs in Geology working for Environmental Consulting firms and Geotechnical Consultants
- these companies detect contamination and clean up soil and groundwater

The Rock Cycle:
- streams are the primary agents of erosion and transport

Streamlines and Fluid Flow:
- turbulent flow can suspend sediment more easily
- turbulence can enhance channel erosion

Stream Load:
- settling velocity is a function of grain diameter
- sediment water moves as suspended load or bed load
- finest clay particles dispersed throughout flow
- finer particles temporarily suspended in flow
- coarsest particles rolling and sliding on bottom as bed load

Sediment Transport: Erosion and Deposition:
- high velocity flows erode their channels
- the threshold between erosion and deposition depends on:
    - velocity
    - grain size
    - strength

Sedimentary Bedforms:
- bedload particles self-organize into large structures
- provide significant clues to the sediment transport and flood history
- Constructional:
    - Dunes
    - Ripples
    - Complex beds
- Erosional:
    - Scours
    - Pits

Sedimentary Bedform Animation:
- computer model shows sediment accumulation and erosion
- Grand Canyon floods caused bedforms

Streams:

- drainage networks
  - stream catchments self-organize into networks of streams defined by their drainage areas
- Mississippi River Basin
  - discharge- flow rate
- Potomac River Basin
  - supplies water to DC, VA, WV and MD
  - rain increases flow rate
- River Valley Structure
  - all rivers have channels, floodplains and tributaries
  - floodplains- on either side of river that floods when too much water in the channel
  - tributaries- streams that flow into the river
- Braided and Meandering Rivers
  - meandering streams:
    - single channel
    - high discharge to load
    - high sinuosity
    - fine grained
    - high suspended load to bed load
    - usually downstream
  - braided streams
    - multiple channels
    - low sinuosity
    - coarse grained
    - high load to discharge
    - usually upstream
    - high bedload to suspend load
- Meandering Streams
  - outside of curve
    - Fast moving water, carries lots of sediments, erosion on cut bank
  - inside of curve
    - slow moving, deposition of sediment occurs, point bars
- Levees
  - edges of river channel formed from sediment deposited during the last flood
- River Profiles
  - Rivers generally decrease in gradient (slope) downstream
  - Commonly, braided streams have steeper gradients than meandering ones

- Base Level

  - Base level- lowest point to which erosion can happen
  - Sea level is the ultimate base level on land
- Base Level Effects
  - Dam construction
    - Makes new base level
    - Upstream deposition
    - Downstream erosion
  - fold growth
    - tectonic deformation (folding) makes new base level
    - stream response: incise through fold
- Deltas: Major Sediment Constructs
  - Rivers carry sediments to lakes and oceans to form deltas
  - Miss. Delta
  - Delta channels are distributary- they carry sediment and water from the river channel into many small channels
  - Will spontaneously rearrange their depositional sites (lobes) during major floods
- The Floodplain
  - Identified by vegitation and other growth
- Floods
  - Water seeps into ground slower than in urban areas

Polar Deserts and Ice Caps
- continental glacier over Antarctica is over 3000 meters thick in many sections, and includes two extensive ice shelves

Permanent Ice
- snow- 90% air
- granular ice- 50% air
- firn- 20-30% air
- glacial ice- <20% air
- glacial ice is long lived with properties like rocks and glass
- holds air trapped as bubbles and wind blown silt

Glaciers
- large volumes of standing ice that flow under the force of gravity
- need cold temps and snow

Ice Budget
- glaciers are moderated by addition of snow at their heads and melting of ice at their toes
- balance between processes determine if glacier grows or shrinks
- top- accumulation dominant
- middle- ablation dominant
- bottom- iceberg calving melting

Icebergs and Glacial Melting
- in article regions, increased melting creates icebergs and decreases ice volumes
- calving- iceberg breakage

Glacial Flow
- flow rapidly and surge at times
- center and top move faster

Crevasse
- brittle fractures at the glacier's upper surface

Glacier Types
- cirque
- piedmont
- valley/ fjord
- ice caps

- continental ice sheers
- sea ice

Glacier Environments
- glaciers create a set of distinct environments by the processes acting within and around them

Glacial Erosion
- can rapidly erode very large volumes of rock
- striae cut by glacial flow marks the flow paths of the ice

Moraines/ Till
- figure 15.1- glacial moraines
- deposited as glaciers are steady or as they retreat
- can represent discrete episodes of glacier growth and ablation
- Long Island and Cape Cod are examples

Drumlins
- large till landforms developed under glaciers, probably in water
- reflect direction of glacial flow (steep side is downstream)

Glacial Lakes
- repositories for fine- grained sediment generated beneath glaciers (rock flour)
- annual layers are varves

Outwash Plains- make lakes

Permafrost- ground permanently frozen

Other glacial landforms:
- fjords- submerged glacial valleys
- kettles- small depressions and scours, often water- filled
- eskers- subglacial river channel deposits (flow under/ through ice)

Test Grades are up on Website

Continental Deglaciation
- ice cover began when Antarctica and Australia separated
- created the circum-Antarctic ocean current
- modern deglaciation helps us predict effects of global climate change
- significant retreat of mountain glaciers

Ice House and Hot House Conditions
- ice volume on continents is inverse to sea level
- changes in ice volume produce sea level changes

Glaciers
- excellent climate records
- annual precipitation makes snow bands every year
- air bubbles trapped in ice cores give direct climate record

Ch 18 Coasts and Oceans

Waves and Currents
- waves and near-shore currents are principle agents of shoreline erosion
- form as a result of the drag of wind on the water surface
- as wave nears shore, drag on bottom slows lower part of the wave
- breaker forms when top part of the wave is so far ahead of bottom part that it collapses

Wave Action
- wave undercutting
- produces wave- cut platforms

Wave Refraction
- almost always come in parallel to shore

Headlands
- when waves hit an irregular coastline, their energy is concentrated towards areas that stand out (headlands)
- stacks: due to erosion, headlands detached from coast

Longshore Drift
- sediment is washed up at angle and drains back perpendicular
- creates current parallel to shore

Deserts and Atmosphere- Ch. 14

atmosphere - the gaseous envelope surrounding Earth
aerosols- small liquids and solids in suspension
humidity- amount of water vapor in the air

- the composition of the atmosphere not including aerosols and humidity:
  - oxygen- 21%
  - nitrogen- 78%
  - argon- .9%
  - water vapor- 1-4%
  - all other- .04%

Atmospheric Structure

- temperature varies with altitude in the atmosphere
- four temperatures zones
- altitudes where temperature changes abruptly are called pauses

Solar Radiation to Earth

- the sun's rays deliver maximum heat perpendicular to the surface

Coriolis Effect and Atmospheric Convection

- coriolis effect- the phenomenon whereby anything that moves freely with respect to the rotating Earth veers off- course
- this effect breaks the flow of air between the equator and poles into the belts
- intertropical convergence zone- low pressure at equator
- huge convection cells transfer latent heat from the equator to the poles
- hurricanes transfer heat from the tropics to higher latitudes, in the form of latent heat

Desert Belts

- many deserts are located between where belts of dry air descend along the 30 degree north and south latitudes

Wind Sediment Transport

- strong winds can suspend and transport fine-grained sediment

Sand Seas: Ergs

- where there is large supply of sand and strong winds, very large dune fields can form
- ergs, or sand seas, cover many hundreds of km squared and contain vast volumes of sand

Eolian Dunes

- strong winds work like water currents- they pile up sand into bedforms and dunes
- some of the world's most spectacular outcrops are fossil sand dunes

Dunes and Dune Complexes
- strong winds can suspend and transport fine- grained sand
- dunes are the most recognizable feature in ergs
- draas are superimposed dune complexes

Loess- accumulation of wind- blown silt and clay

Evaporative Lakes – arid, hot conditions lead to evaporation of standing bodies of water, depositing evaporate materials

Desertification- invasion of desert conditions into non- desert areas by natural of anthropogenic processes

Oceans
- cover 71% of Earth's surface
  - Arctic, Atlantic, Pacific, Indian and Southern
- consists of three principle layers
  - thin upper surface layer of well stirred water
  - transitional thermocline
  - thick deep zone of colder water that is calm and slow moving
- mixing of the ocean occurs over timescales of 1000's of years
- salinity- the amount of dissolved solids in seawater

Attributes of the Gulf Stream
- Ben Franklin mapped the Gulf Stream in about 1770
- A surface current that carries heat to Europe
- The maximum current speed is usually about 2m/sec
- 80 to 150 kilometers wide
- affects upper 100- 500 meters of water
- caused by variations in the wind and the coriolis effect
- friction between windblown air and surface cause the water to move and its deflected by continents

Tropical Ireland
- a striking example of the climate influence of the Gulf Stream
- the two islands have approximately the same latitude, but are in different hemispheres
- Bouvet Island is very cold and icebound
- Ireland has tropical palm trees

Turbidites
- graded bedding forms when a rapidly plowing turbid slurry of water and clastic sediment slows down and the largest clasts settle first
- Olympic Peninsula, Washington

Tsunami
- as the tsunami approaches the shore, the water column piles up, increasing the wave height to dramatic proportions
- movement of the ocean floor by earthquakes, volcanic eruptions, or submarine landslides often produce anm unusually large wave called a tsunami
- tsunami has a large wavelength and travels at high speeds

Coral Reefs and Atolls
- reefs form a unique coastal feature since they are biological in origin
- modern reefs are built by a complex community of coral, algae, sponges, and other marine invertebrates
- most reefs grow in warm shallow tropical regions

Announcements:
- homework due Monday, http://vcourseware5.calstatela.edu/virtualearthquake/vquakeintro.html

Accumulation of slip:
- leaves record over time
- shifts ground by large distances

Fault Planes
- slickensides are mineral fibers that grow on fault surfaces

Epicenters
- the earthquake happens at some depth in the earth (the focus)
- epicenter- point directly about the focus

P and S waves
- P waves are compression waves like sound waves, they push and pull rocks and are faster than S waves
- S waves are shearing waves, sinous waves that swing up and down

Surface L and R waves
- love
- Raleigh

Seismometer
- measure earthquakes
- need three, one for each motion

Earthquake Hazards
- richter magnitude- based on amplitude amplitude of recorded wave
- mercalli intensity- based on damage
- moment magnitude- based on amount of energy released

Earthquake Hazards
- splitting of ground
- causes landslides and mudslides
- liquefaction of soft sediments
- fires from broken gas mains and drowned electrical lines
- buildings fall on homes and people

Fault Motion

- normal fault- tensional forces
- thrust fault- compressive forces
- strike-slip fault- shearing forces

Paleoseimology
- records of old earthquakes can help predict the future
- seismic gaps- parts of the fault that haven't broken in a long time
- recurrence interval- on average, how often do earthquakes occur on a particular fault
- first done along the San Andreas Fault
- routinely done by trenching across faults and collecting samples for carbon dating

Probabilities
- red faults are more likely to fail
- graphs show earthquake probability in 50 years

Ch 19- The Earth's Interior

Layers:
- crust
- lithosphere
- asthenosphere
- mantle
- core- mantle boundary
- liquid iron outer core
- solid iron inner core

Drilling through the crust:
- drill holes are expensive
- the deepest ever drill hole bottoms only 12 km down
- continental crust averages 45 km thick
- drill core can be equivalent to a long surface outcropping of rock

Mantle Samples
- xenolith- a fragment of rock that is carried to the surface by magma
- diamond- forms at a minimum of 150 km depth

Experimental Petrology and Geochemistry
- the diamond anvil cell- capable of reaching megabar pressures

Travel Paths of Seismic Body Waves
- curved ray paths- from focus out towards crust of earth

Seismic Velocities and Earth Structure
- P- waves travel slower in liquids
- S- waves do not travel in liquids
- Discontinuities represent changes in composition or state of matter

Chesapeake Bay Video: Vanishing Lands

30 islands disappeared in 30 years
- land broken
- trees fallen

Cooper's Island
- lost 50ft. in few years
- land being eroded
- water covering land

Process:
- global warming
- glaciers melt
- more sea water
- water warms
- sea expands

sea level in Bay rose 1 foot in past century- more than twice the world wide sea level rise, 1ft water = 1 mile of land

Bay lands are sinking:
- irrigation
- ground water remove
- land weakens

Effects Water Quality
- dirt from land goes into water
- kills plants and wildlife

Problems on Shore
- wildlife
- can't build dikes
- houses on shore in danger

Ocean City
- rebuilt beach from 1987 to 1991
- made dunes to protect property
- 30 year storm hit and ruined 90% of beach work

Slides:

Crust and Mantle
- seismic cross- section: continents "float" on the mantle like iceburgs, except the mantle is solid

Earth's magnetic field
- approximated as a dipole
- similar to a bar magnet
- invisible magnetic field
- iron-rich minerals in molten rock will orient towards magnetic north when they cool and solidify
- polarity- the N-S directionality of the Earth's magnetic field
- normal polarity
- reverse polarity- every ½ million years earth's magnetic field direction changes

Ch. 21, Deformation of Continental Crust

Cratons- stable, interior, relatively undeformed, oldest

Pangea
- most recent supercontinent
- assembled fully about 250 million years ago

Orogenic Belts:
- older, interior mountain belts on inside of Pangea
- newer, peripheral mountain belts on outside of Pangea

Review for Test on Friday

- Amazon supplies 20% of all the fresh water that enters the ocean
- Every American uses 3.5 million pounds of minerals, metals and fuels in a lifetime
- Until this last century the population was below a billion
- Because of so many people, there is a strain on resources

Resources:
- renewable vs. non-renewable
- reserves(proven can be economically extracted) vs. inferred resources (from total number of recources inference can be retrieved)
- fossil fuels- organic material trapped in rock ultimately derived and photosynthesized form the sun

Oil:
- petroleum is composed of oil (liquid hydrocarbons) and natural gas (made mostly of methane)
- oil needs to be concentrated from its source rock into a reservoir before it is economically extractable
- hydrocarbons (molecules of mostly hydrogen and carbon) that are combusted release energy- which is why they are useful as fuels

Five Play Elements:
- source rock (where oil comes from)
- maturation and migration (cooking the source)
- reservoir (what holds oil)
- trap (keeps oil from flowing to the surface)
- seal (closes off reservoir to make big accumulation)

- oil mostly comes from algae goo

Oil Traps:
- trap in Anticline
- fault trap
- stratigraphic trap
- salt dome trap
- salt, when buried, flows like a viscous fluid, which deforms the surrounding rocks and makes faults and folds in nearby rocks
- most famous salt dome- Avery Islands Salt Dome- where tobasco sauce is made

Resources- sum of total on Earth of a specific thing
Reserves- sum on Earth that is economically accessible and useful

Fossil Fuels:
- oil
- coal- made of land plants in swamps that were buried (peat- compacted plant which burns) and chemically changed to form coal

Environmental Impacts of fossil fuels:
- oil spills
- smog- from burning carbon-based fuels
- acid rain
- acid mine drainage
- carbon dioxide production
- natural gas produces least amount of carbon dioxide in terms of energy content
- coal makes most carbon dioxide and also releases sulphur, lead and silicates

Nuclear Energy:
- fission (breakage) of large uranium atoms
- fission releases heat
- heat boils water which turns turbine to create power

Environmental Impacts of Nuclear Energy:
- saves space
- efficient
- radioactive nuclear waste
- risk of plant accident to release radioactive into environment
- dangerous to mine

Solar Power:
- clean, inexpensive
- non-reliable
- inefficient (only 15-20% turns into power)

Geothermal Plant:
- hot rocks produce steam
- The Geysers in CA

Ch. 22- Energy

Fossil Fuels:

- oil and gas form from the transformation of organic matter from marine micro- organisms
- when they die, they settle on the sea floor
- after initial rapid burial, continued burial transforms organic material first to heavy oils
- then to lighter oils
- and eventually natural gas
- to form economic deposits, oil and gas must migrate and accumulate in traps or reservoirs
- because oil and gas are less dense than water also held in the ground, they rise along permeable layers, displacing the groundwater filling the pore space, until an impermeable cap is encountered

Oil Traps:

- Anticline
- Fault trap
- Stratigraphic
- Salt dome

Salt Diapers:

- salt, when buried, flows like a viscous fluid
- this deforms the surrounding rocks
- Avery Island

Stratigraphic Traps:

- where reservoirs terminate
- fossil reefs- excellent reservoirs

Fossil Fuels: Coal

- coal forms from the rapid burial, and transformation of land plants under increasing pressure and temperature
- large coal deposits are produced where abundant land plants occur and where oxygen-poor conditions exist, such as tropical swamps
- dead plants are first converted to peat, then to a sequence of progressively denser and dryer coals under conditions of increasing pressure and temperature

Environmental impacts of fossil fuel usage: mining

- coal mining is either underground or above ground
- above ground mining involves removing overburden down to a layer of coal then systematically extracting the coal
- this practice is called strip mining and results in extensive land disturbance

Improved Drilling Technology
- technological advances really have lessened environmental impact
- horizontal drilling (fewer platforms)
- high capacity engineering (fewer wells)
- segmented pipelines
- raised pipelines
- bioremediation
- oil spills still occur

Oil Shale
- organic- rich rock
- can be mined
- has enough organic material to burn or heat and extract material

Tar Sands
- sandstone filled with thick petroleum material
- mined like a rock
- heat and extract petroleum

Alternative Sources of Energy
- wind
- sun
- water
- nuclear
- biomass

Challenges of Greenhouse mitigation

CFC's (ozone depression)
- unambiguous chemistry
- unambiguous physics
- simple system (upper atmosphere)
- well defined problems
- few sources of CFC's
- simple chemical solutions

Greenhouse / CO_2 emission

- complicated chemistry
- unambiguous physics
- complex system
- poorly defined problem
- many sources of greenhouse gases, natural, industrial, agriculture, and polyeconomic
- no obvious chemical or engineering fix