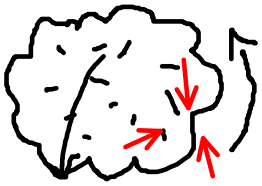
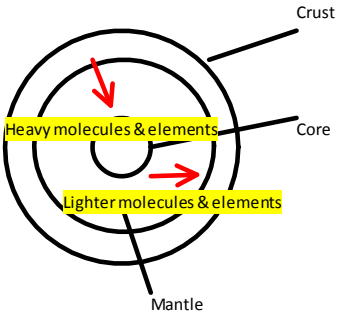
Earth Sci 1022A

INTRO 09/12/2013

- Geology- Geo:Earth Ology:the study
  - All affected directly or indirectly
- Uniformitarianism- the processes we see going on on the surface of our planet have always gone on.
  - "The present is the key to the past".
- Geology deals with around 4.6 billions of years (scientific view).
  - Earth comes from nebular hypothesis (5 b.y ago).
    -Nebula (cloud) of hydrogen &helium contracted under gravity into our solar system.
    -Formed core, mantle and crust of earth.
    -Rocky fragments during nebular hypothesis created earth.
    -Nebula spins and pulls heavy particles in and light out.

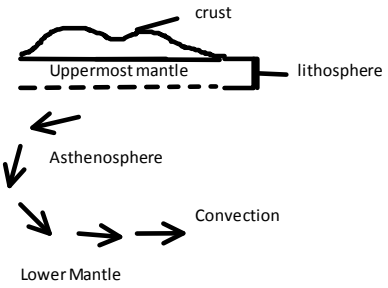
1. Nebula





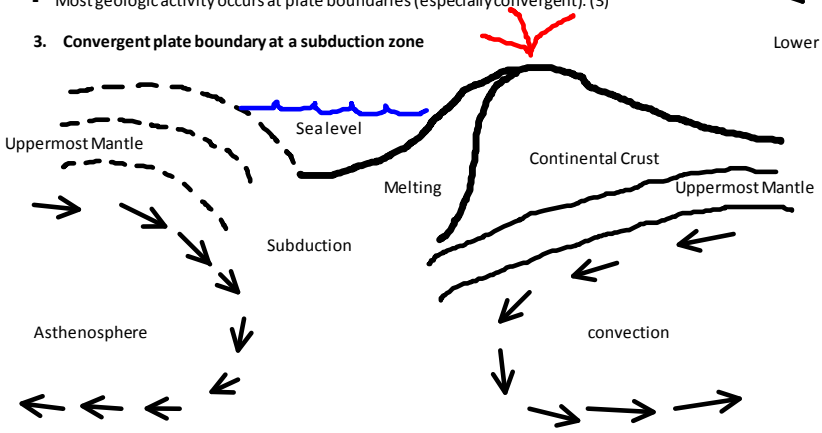
- Plate tectonics
  - Lithosphere that rides on the liquid asthenosphere, which moves by convection, always moving.
    -Lithos: Latin for rock **(2)**

2. Lithospheric plate



- Alfred Wegner- plate tectonic theory.
  - Continental drift: thought that 2oo m.y. ago there was a continent- pangea.
    -Fit of all continents (mostly south America and Africa)
    -Fossils matched across ocean.
    - Rock types identical in mountain ranges on areas where continents were connected
    -Ancient tropical natured deposits that should not be there unless pangea happened.
    -Glacial rocks where they could not exist today and coal fields in today's cold polar areas.
  - Most geologic activity occurs at plate boundaries (especially convergent). (3)

3. Convergent plate boundary at a subduction zone



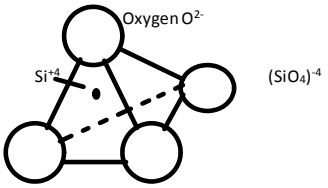
Oceanic crust diving under continental crust

- Earth system and rock cycle
  - Earth is a system of interacting hydrosphere, atmosphere, biosphere, and geosphere
    -Material recycled in the rock cycle

MINERALS- CHAPTER 2 09/17/2013

- Mineral- fd chemical compound found in nature, contain molecules.
  - Most abundant minerals are called silicates
    -silicon-oxygen tetrahedron (**T-39**)
    -tetra=4 hedron=pyramid
    -4 oxygen=1 silicon
    (4)

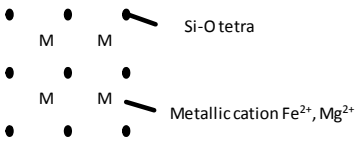
4. Si-O tetrahedron



- Common silicate minerals- **ferromagnesian** (dark) silicates

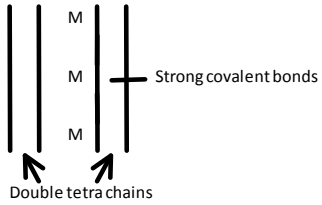
- Olivine: single tetrahedral bonded Fe^{+2}, Mg^{+2} ions **(5)**

5. **Olivine**

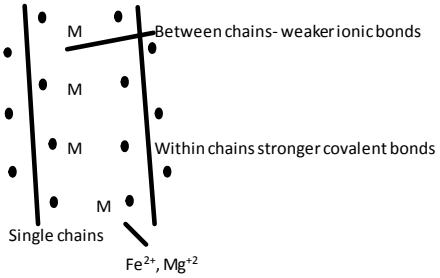


- Pyroxene: single chains of tetrahedral, ~90 degrees cleavage
- Amphibole: double chains, ~120 degree cleavage
- Biotite: (black mica) tetrahedral sheets with perfect (basal) cleavage **(6)**

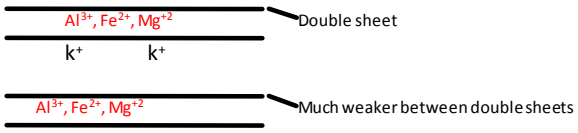
6. **Amphibole- double chains**



6. **Pyroxene- single chain**



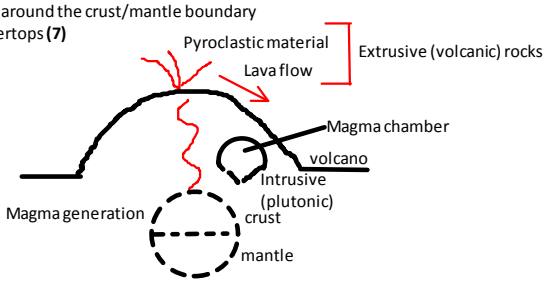
6. **Biotite sheet silicate**



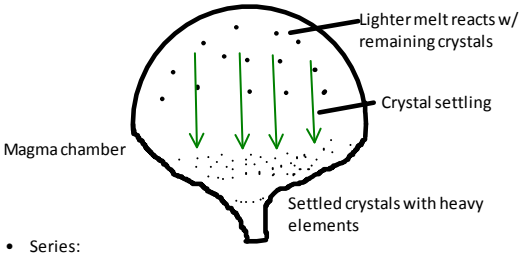
- Ferromagnesian (light) silicates
  - Muscovite: (white mica), perfect (basal) cleavage
  - Feldspar: network silicate, 2 types:
    -Network silicate, 2 types: Orthoclase (pink K feldspar) and plagioclase (Ca-Na feldspar)
  - Quartz: all tetrahedral (SiO^2), no cleavage, hardness of 7
- Important Nonsilicate Minerals:
  - Carbonates: metals bonded to $(CO_3)^{-2}$ group
    -Calcite: $CaCO_3$
    -Dolomite: $CaMg(CO_3)_2$, magnesium replaces some of the calcium
  - Minerals formed by evaporation
    -Halite: NaCl, common salt; also used for chlorine, baking soda.
    -Gypsum: used to make plaster and drywall, $CaSO_4 \cdot 2H_2O$

IGNEOUS ROCKS-CHAPTER 3 09/19/2013

- Form from fire, crystallize from hot material deep in earth
  - Melts from pressure, around the crust/mantle boundary
    -Granite countertops **(7)**



- How Magmas evolve
  - Studied by Norman L. Bowen, Kingston, ON
    -Bowen's reaction series, in which crystals settle in a magma chamber
    -Earlier dark crystals remove heavy elements, leaving melt with lighter ones (magmatic differentiation) **(8)**



- Series:
  - Discontinuous series (different structures)
  - Continuous series (plagioclase structure)
  - Assimilation (host rock melts in magma), magma mixing

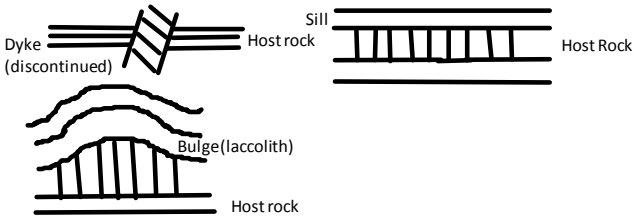
- Igneous compositions:
  - Dark versus light mineral (i.e. Silica vs Fe, Mg) content

- Igneous textures:
  - Aphanitic (fast cooling magma, small crystals) almost invisible because of fast cooling.
  - Phaneritic (slow cooling magma, large crystals) visible because of slow cooling, does not make it to ground surface.
  - Porphyritic (large crystals surrounded by smaller ones)
  - Glassy (quenched, no crystals)
  - Pyroclastic (airborne pieces of magma fell to the ground)

- Naming igneous rocks
  - Felsic (~70% silica)
    - -Granite (in cores of mountains)
    - -Rhyolite (volcanic)
  - Intermediate (~60% silica)
    - -Andesite (from volcanoes above subduction zones)
    - -Diorite (in intrusive rocks above subduction zones)
  - Mafic (~50% silica)
    - -Basalt (most abundant rock, forms oceanic crust)
    - -Gabbro (in lower oceanic crust)
  - Ultramafic (~45%)
    - -Peridotite (in upper mantle) rocks

- Intrusive igneous bodies
  - Forms plutons with two orientations:
    - Discordant, cut across host
    - Concordant, parallel to host rock **(9)**

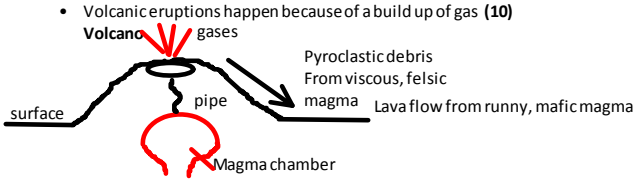
9. Plutons



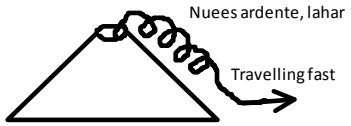
- Types of plutons:
  - Dykes: discordant, tabular
  - Sills: concordant, tabular
  - Laccoliths: concordant, bulge
  - Batholith: discordant, bulge

VOLCANOES- CHAPTER 4 09/24/2013

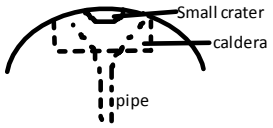
- Volcanic eruptions happen because of a build up of gas **(10)**



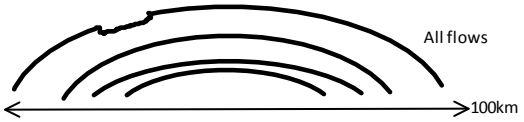
- Materials extruded
  - Lava flow:
    - -Hotter, runny pahoehoe (ropy)
    - -Cooler, viscous aa (blocky)
  - Pillow lavas form under water, pyroclastic material ranges from fine ash to large bombs
    - -Nuee ardentes (very hot cloud of ash & gas); lahars (wet ash flow) **(11)**



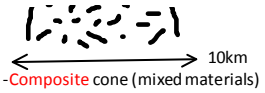
- Volcanic Structures **(12)**



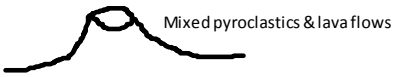
  - Types of volcanoes:
    - -Shield (broad dome of lava flows) **(13)**



    - -Cinder cone (small, pyroclastic)



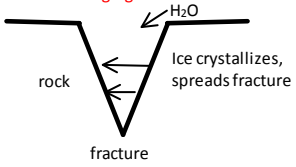
-Composite cone (mixed materials)



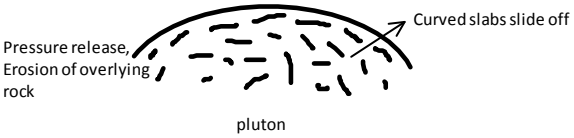
- Fissure eruptions pour lava onto land to build up lava plateaus

WEATHERING AND SOILS- CHAPTER 4

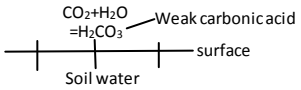
- Mechanical Weathering
  - Breaking up rock into smaller pieces, providing more surfaces for chemical attack
  1. Frost Wedging: water freezes in rock fractures and expands 9%, prying rock **(14)**



  2. Unloading: Rock surface expands after stuff of top is removed, slabs break off **(15)**

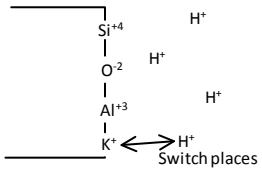


  3. Biologic activity: Plant roots grow in rock fractures and pry the fractures open
- Chemical Weathering
  1. Dissolution: CO_2 dissolves in water to make weak carbonic acid that dissolves rock minerals **(16)**



  a. Oxidation: dark silicates react with oxygen; form Fe, Mg oxides, clays
  b. Hydrolysis: Orthoclase in granite changes to clay by exchanging large K^+ ions for tiny H^+ **(17)**

Feldspar crystal



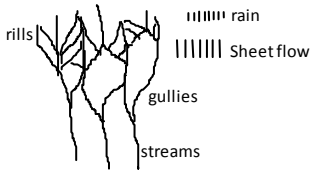
- Rates of weathering:
  - Rock characteristics:
    - -light silicates form closer to weathering conditions, more stable;
    - - marble is soluble, unstable
    - -dark silicates form under high P, T conditions, unstable under weathering conditions
  - Climate: weathering is greater in warm, wet climates

- Soil

O horizon: humus (like compost)
A: humus and rock materials
E: removal of soluble ions
B: accumulation of oxides, clays
C: regolith (weathered parent material)
unaltered parent material

  - Biologic activity combined with weathering (produces regolith without biological input); added organics are called humus
  - 5 main factors in soil formation...
  a. Parent material: rock or sediment on which soil forms
  b. Time: longer, more soil formation
  c. Climate: slow in cold, dry areas
  d. Plants, animals: provide humus
  e. Topography: erosion, water retention (slope of the land)

- Soil Erosion **(18)**

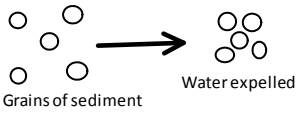


  - Raindrops: displace soil particles
  - Rills become gullies which join to form streams and remove soil
  - Made worse by deforestation- removes plants that protect soil
  - Eroded soil clogs reservoirs, lakes

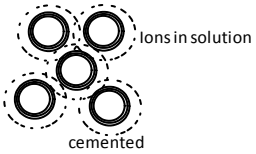
-Reduces holding capacity

SEDIMENTARY ROCKS- CHAPTER 6 10/01/2013

- Sedemental=to settle
  - Diagenesis
    - -Lithification
      - -Compaction: sediment compressed into smaller volume, thinner **(19)**



      - -Cementation: minerals precipitate in pore spaces - mainly calcite, silica, iron oxides **(20)**

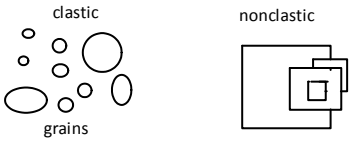


- Detrital sedimentary rocks
  - Mainly settled rock fragments, clay from the weathering of plutonic rocks and quartz
  - 3 main types:
    - Shale: from settling of fine particles in quiet water
      - -Good cap rock for oil and gas (s7)
    - Sandstone: well sorted if grains of similar size; poorly sorted if a mix in sizes
      - -mainly quartz grains; called arkose (s14) if it has lots of feldspar (s11)
    - Conglomerate: from muddy gravel deposited down slopes or by currents, waves
      - -Particles travelled far, rounded (s9)
      - -Breccia: particles deposited close to source, still angular

- Chemical sedimentary rocks
  - Ions from chemical weathering precipitate in sea or ponds
  - Shells of organisms form biochemical sed. Rocks
  - 5 main types:
    - -Limestone: made of calcite in:
    - Micrite (sea water) (s10)
    - Fossiliferous limestone (coral reefs) (s2)
    - Coquina (shells on a beach) (s12)
    - Chalk (plankton on sea floor)(s8)
    - Travertine (caves) (s1)
    - -Dolostone: Ca^{+2} partly replaced by Mg^{+2} in calcite of limestone
    - -Chert: mainly remains of plankton with skeletons of silica; used for arrowheads, spears (s15)
    - -Evaporites: rock salt(s16), rock gypsum(s5), potash in shallow seas, salt flats-
    - -Coal: ancient plant matter in ancient swamps(s6)

- Classification
  - Clastic: fragments of rocks and minerals in detrital sed. Rocks
  - Nonclastic: interlocking crystals in chemical sedimentary rock **(21)**

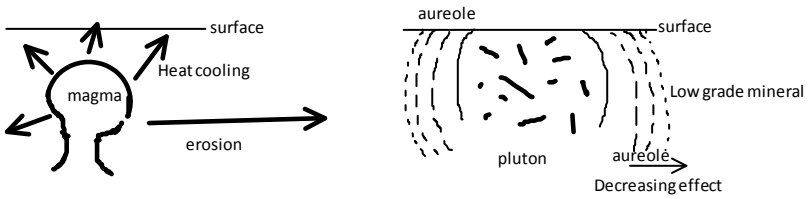
Sedimentary rock textures



METAMORPHIC ROCKS- CHAPTER 7 (10/02/2013)

- Metamorphism- to change form
  - Solid state, no melting involved

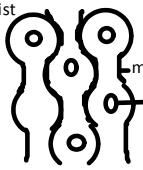
- Controlling factors
  - Parent rock: controls composition
  - Heat: most important, drives chemical reactions and recrystallization of host rock
  - Pressure: increases with depth;
    - -Confining pressure and directed pressure
  - Chemical activity: ions in solution exchange with ions in minerals of the parent rock to form new minerals
- Metamorphic grade
  - Increases with temperature
  - Index minerals from low grade to high grade
- Contact metamorphism
  - Local effect by magma intruding host rocks
  - Metamorphic aureoles form **(22)**



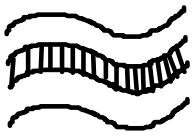
- Minerals recrystallize but are not reoriented
- Nonfoliated metamorphic rocks:
  - Marble: coarse interlocking crystals of calcite
  - Quartzite: coarse interlocking crystals of quartz
- Regional Metamorphism
  - Larger scale in the cores of mountains built by colliding plates
  - Directed pressures orient (align) recrystallized minerals (foliation)
  - Most intense in the "roots" of mountain belts
- Regional metamorphism of shale: **(23)**
  - Slate: fine, parallel mica flakes

  - Phyllite: slightly larger flakes
  - Schist: foliation easily visible

schist



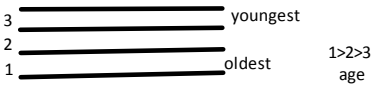
  - Gneiss: banded or contorted



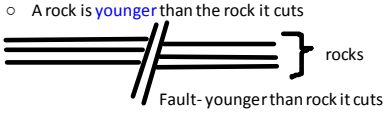
Light& dark minerals seperate

CHAPTER 8- GEOLOGIC TIME 08/10/2013

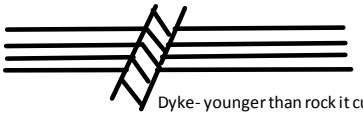
- Relative time
  - Superposition: each bed is older than the one above, and younger than the one below **(24)**



  - Original horizontality: sediment is usually deposited horizontally
- Cross-cutting relations **(25)**
  - A fault is younger than the rock it cuts
  - A rock is younger than the rock it cuts

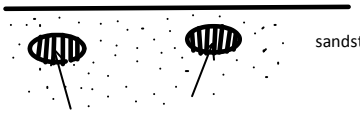


Fault- younger than rock it cuts



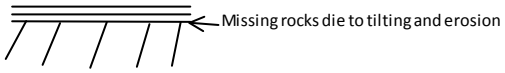
Dyke- younger than rock it cuts

- Inclusions: inclusions are older than the rock containing them **(26)**

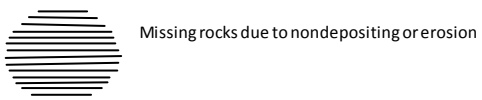


Inclusions of older, pre-existing (eroded) rock

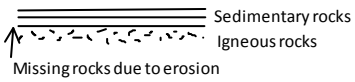
- Unconformities
  - Angular unconformity: between flat and tilted, eroded beds **(27)**



  - Disconformity: between parallel beds **(28)**

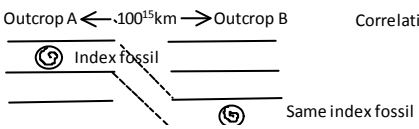


  - Nonconformity: between flat beds on eroded igneous, metamorphic rock **(29)**



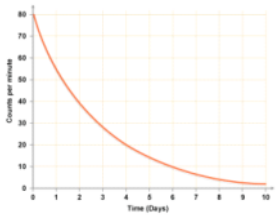
Missing rocks due to erosion

- Correlation: **(30)**

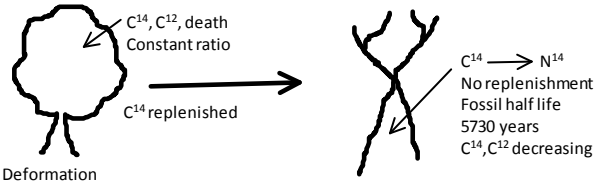


- Matching rock features, fossils...
- Fossil succesion: organisms evolved along distinct pathways through geologic time, left index fossils

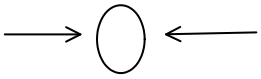
- Dating with Radioactivity **(31)**
  - Radioactive isotopes (parents) decay to daughters over time
  - Time it takes to decay to half the amount of parent left is the half life of the isotope
  - Compares parent left with half life, gives time since rock formed



Radiocarbon (C^{14}) Dating **(32)**
- In organisms C^{14} decays to N^{14} with half life of 5730 yrs but is replaced by C^{14} from the air
- In fossils C^{14} decays but is not replaced; used $C^{14/12}$ ratio and half life to get time since death

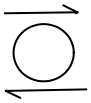


- Deformation
  - Stress (force) on rocks:
    - Compressional- squeezing **(33)**



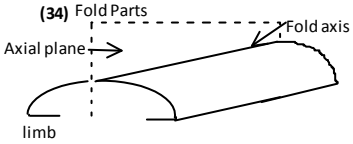
    - Tensional- stretching

    - Shear- slipping sideways

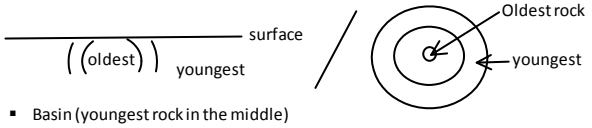


    -Strain results from stress
    - Under stress, rocks can exceed the elastic limit before flowing (ductile deformation) or being fractured (brittle deformation)
    - Brittle def. Common near surface; ductile def. Common
  - Mapping geologic structures
    - Strike- azimuth of a horizontal line on the surface of a plane
    - Dip- angle of inclination of the surface from horizontal

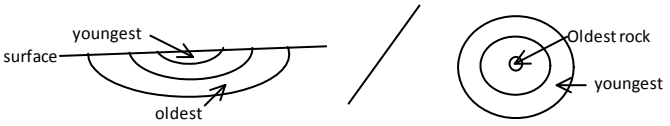
(34) Fold Parts



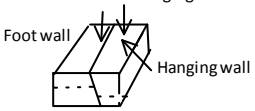
  - Folds: compressional forces
    - Anticline (arch)
    - Syncline (trough)
    - Monocline (step)
    - Dome (oldest rock in the middle) **(35) cross section/map view**



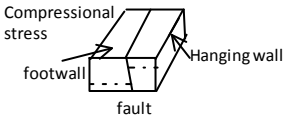
    - Basin (youngest rock in the middle)



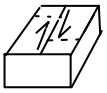
  - Joints: fractures but no displacement
  - Faults: displacement of rocks
    - Dip slip: along dip or fault
    - Normal- hanging wall went down **(36)**



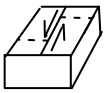
- Reverse/thrust- hanging wall went up



  - Strike slip: movement laterally along strike of fault **(37)**
    - Right lateral: rocks displaced to the right

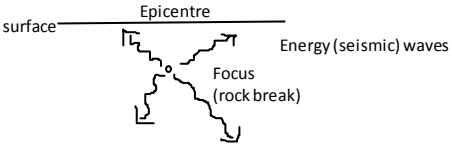


    - Left-lateral: rocks displaced to the left



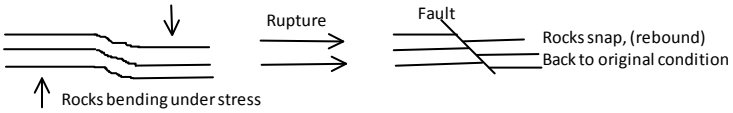
EARTHQUAKES- CHAPTER 10 (10/15/2013)

- Cause
  - Slippage along fault in the crust at the focus
  - Occurs below the spot plotted on a map called the epicentre **(38)**



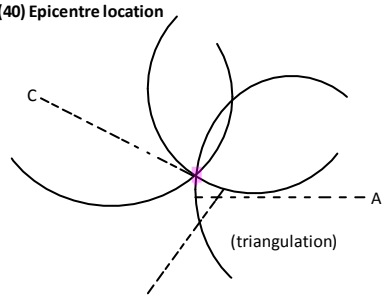
  - Elastic rebound: rocks bend until they rupture (earthquake), then stress builds up and they start bending again **(39)**

  - Foreshocks and aftershocks common with main event



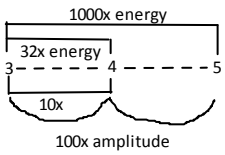
- Seismology
  - Surface waves: slowest (l)
  - Body waves: travel through rock
  - Compressional (like slinky toy), primary (p), faster
  - Shear (starts up and down motion), secondary (s), slow, half the speed of p wave
- Locating the source of an earthquake
  - Record p, s wave arrival times, time difference on time-travel curves gives the distance from the station to the epicentre
  - Plot distances from at least 3 station arcs; 3 arcs intersect at the epicentre **(40)**

(40) Epicentre location



- Measuring the size of Earthquakes
  - Richter scale: based on energy released by the earthquake
  - Each number 10 times largest wave amplitude or ~32 times the energy of the last number
  - Moment magnitude better for large earthquakes **(41)**

Richter scale

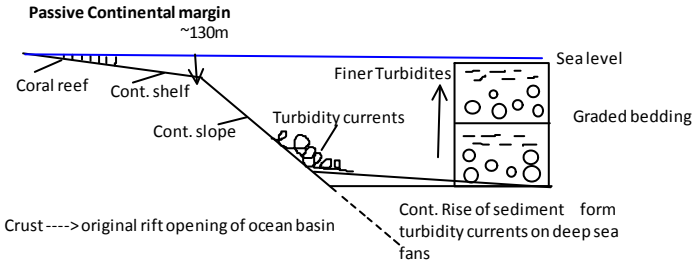


- Probing Earth's interior
  - At material boundaries part of a seismic wave is reflected, part refracted
  - Wave speeds up or slows down crossing the boundary
- Major Boundaries
  - Crust mantle: both waves speed up
  - Mantle-core: p slows down, s waves disappear in a liquid outer core
  - Inner core: p waves speed up in solid inner core

CHAPTER 11- THE OCEAN FLOOR 10/13/2013

- Continental Margins

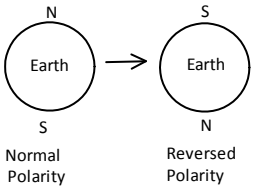
- Passive: no volcanoes, few earthquakes; 3 parts... **(42)**

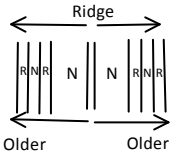


  - Continental shelf- gentle gradient to ~130m depth
  - Continental slope- steeper slope beyond the shelf
  - Continental rise- gentle slope under deep-sea fan sediments
  - Submarine canyons- valleys carved by rivers into the continental slope during lower sea level or by turbidity currents
    - Turbidity currents deposit turbidites with graded bedding
    - Active: at subduction zones with deep-ocean trenches and accretionary wedges
- Deep-Ocean Basin
  - Deep-ocean trenches: At the edges of subduction zones
  - Abyssal plains: flat- hide rugged terrain covered with fine sediments.
  - Seamounts: underwater volcanoes
- Coral Reefs and Atolls
  - Reef: skeletal remains of corals that grow in warm sunlit sea water up to 45m deep (ex. Great barrier reef)
  - Atoll: ring-shaped reef around a submerged volcano
- Mid-ocean ridges
  - Submarine ridge system with wide rift valleys that are offset by transform faults
    - Fresh seafloor cools and contracts as it moves toward abyssal plains

CHAPTER 12- PLATE TECTONICS 10/22/2013

- Continental drift and paleomagnetism
  - Magnetic minerals act like fossil compass needles pointing to where paleo magnetic poles used to be
  - Divergent polar wandering paths show that continents drifted apart
  - Seafloor spreading moves seafloor away from oceanic ridges toward ocean trenches
  - Geomagnetic reversals: magnetic poles have reversed polarity; "striped" ea floor gets older away from oceanic ridges **(43)**

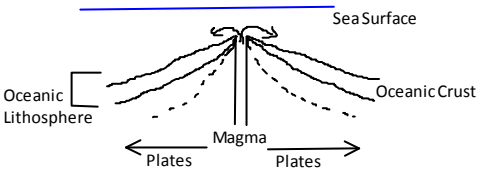




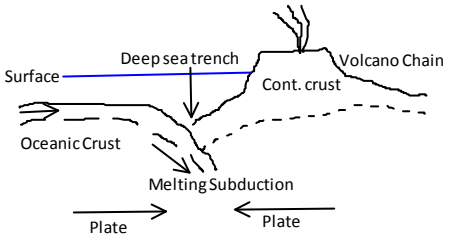
N=Normal

R=Reversed

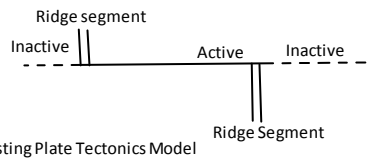
  - Rigid plates of lithosphere
- Plate Tectonics
  - 7 major plates of rigid lithosphere ride on plastic asthenosphere
  - Interactions of plates cause earthquakes, volcanoes, and mountain building
- Plate Boundaries
  - Divergent: plates move apart- sea floor spreading, as well as rift valleys on continents **(44)**



  - Convergent: plates move together- subduction at ocean trenches **(45)**



  - Transform fault: plates slide past eachother sideways **(46)**



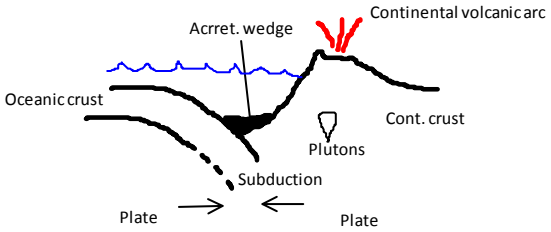
- Testing Plate Tectonics Model
  - Earthquakes: most occur at the edges of lithospheric plates

- Ocean drilling: sea floor sediment gets deeper and older away from mid-ocean ridges
- Hot spots/Mantle plume: where chain of volcanic islands and seamounts forms as a plate moves over a magma plume in the mantle
  - Driving Mechanism: Mantle convection

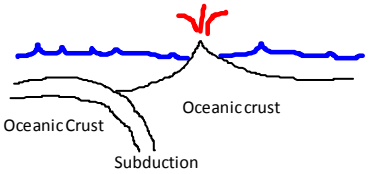
CHAPTER 13- MOUNTAIN BUILDING AND OROGENESIS 11/04/2013

- Isostasy- Continental crust is lighter than the oceanic
- Creation of ocean basins from division of a supercontinent (pangea)
- Mountains and Plate Tectonic Environments (margins)
  - Divergent- continental lithosphere uplifted, splits over mantle plume rift valley, volcanoes along sides
  - Passive- rift widens to an ocean basin with quiet margins, seds.
  - Convergent- various types **(47)**

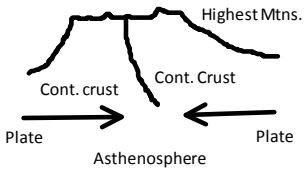
    - Andean: oceanic crust subducts under continental crust, forming accretionary wedge, continental volcanic arc and andesitic to granitic plutons



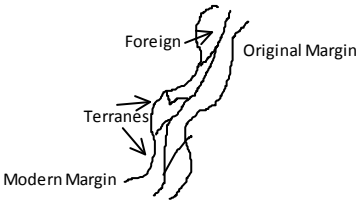
    - Aleutian type: oceanic-oceanic volcanic island arc



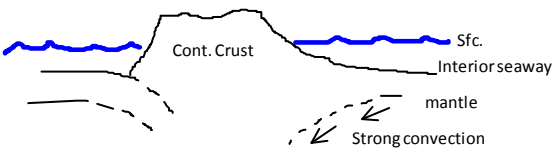
    - Continental collision: ocean closes, subduction stops, high mtns.



    - Accreted terranes: foreign crustal fragments stuck onto margin **(50)**



  - Broad Vertical Movements
    - Uplift- mantle upwelling pushes up lithosphere in continental interiors
    - Subsidence- sediment load along passive margins, or downward flow in the mantle under continental lithosphere



  - Origin and Evolution of continents
    - Original continental crust probably formed by coalescing volcanic arcs above subduction zones
    - Today the earliest continental crust is found in shield areas of continental interiors

CHAPTER 14- MASS WASTING 11/07/2013

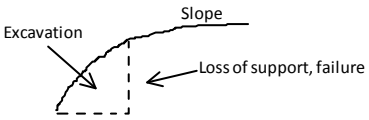
- Controls and Triggers
  - Gravity is always pulling rock, regolith, and soil down slopes; more effective if…
    - Water saturates materials on slopes- reduces cohesion, friction and adds weight **(52)**

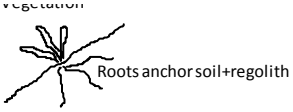
Water saturation

Filled w/ water
-Reduces friction
-Adds weight

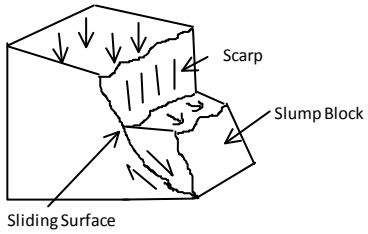
    - Oversteepened slopes: from undercutting, loss of support **(53)**

Vegetation

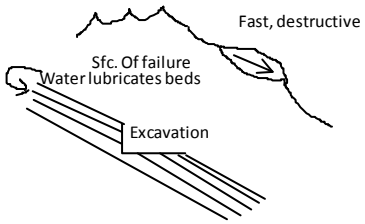




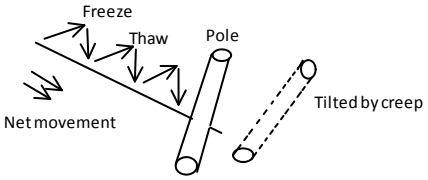
  - Vegetation removal: plant roots anchor and stabilize soil
  - Earthquakes: dislodge slope materials, start landslides
- Classification
  - Slump: rotation of a block of slope materials along a sliding surface



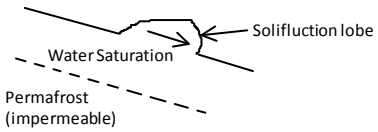
  - Rockslide: common where rock structures parallel slope, provide sliding surface, or where strong rock rests on weaker rock **(55)**



  - Debris flow: fast flow of saturates soil and regolith down valleys following heavy rain; includes Volcanic ash in lahars
  - Earthflow: ongoing movement of mud down a hillside after heavy rain or snowmelt
  - Creep: gradual downslope movement of soil and regolith by gravity, freezing & thawing



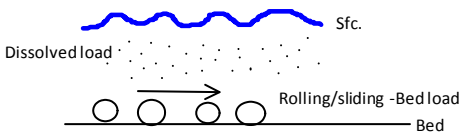
  - Solifluction: flow in saturated ground above impermeable rock, clay, or permafrost



  - Submarine landslides: as slumps, debris flows, turbidity currents

Chapter 15- Running Water 11/12/13

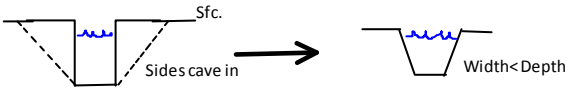
- Hydrologic (water) Cycle
  - Water is trasferred from the oceans to land then...
    - Infiltration, runoff, evaporation, transpiration by plants, some locked up in glaciers
    - Most returned by streams
- Stream flow
  - Gradient: channel slope-steeper, faster flow
    - Cross sectional shape: can slow stream flow by friction
- Discharge: volume of water flowing through stream cross section each second
  - As discharge increases other stream parameters (width, depth, velocity) also increase
- Work of streams
  - Erosion: use particles as tools to abrade (sand blast) channel walls and floor, including potholes
  - Transport: streams carry sediment loads in 3 ways: **(58)**



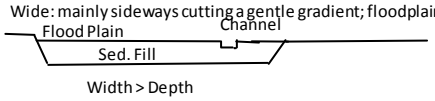
1. Dissolved- ions in solution from chemical weathering (invisible)
2. Suspended- finer particles in the water column
3. Bed load- Coarser particles sliding and rolling along the channel floor

- Saltation occurs when particles alternate between the bed and suspended loads **(59)**
  Saltation
  Jumping & skipping

- Deposition occurs when a stream slows down - big particles settle first, then smaller ones...
  - Coarser channel deposits as bars; finer floodplain deposits
- Stream valleys
  - Narrow: V-shaped by down- cutting on a steep gradient as the sides cave in; waterfalls and rapids common **(60)**



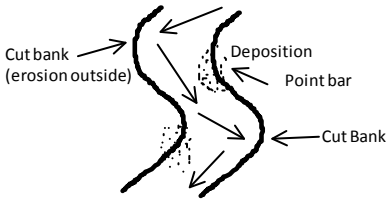
  - Wide: mainly sideways cutting a gentle gradient; floodplains **(61)**



    - Meanders form on a floodplain as the stream shifts sideways by cutting into the outsides of meander bends at cut banks and depositing on the insides of bends at point bars **(62)**

Meanders

Migrates ←

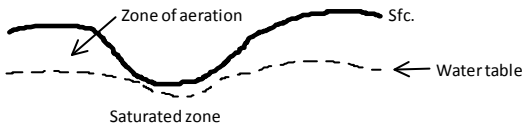


  - Cutoffs and oxbow lakes result from streams trying to straighten their channels
  - A delta form where a stream flows into standing water and splits into distributaries, trying to carry it's load down steeper slope
- Drainage Networks
  - Dendritic: on uniform bedrock (tree like)
  - Radial: from a mountain peak (or volcano)
  - Rectangular: controlled by joint or fault system; right angle beds
- Floods and food control
  - Artificial levees: earth mounds on stream banks to increase the volume of water in channel
  - Dams: to regulate water storage and flow; also for irrigation, hydroelectric power, recreation

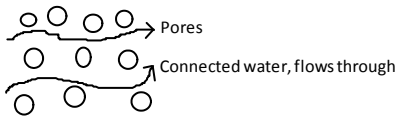
CHAPTER 16- GROUNDWATER 11/14/2013

- Distribution of underground water **(63)**

Groundwater Zones



  - Zone of saturation: pores filled with water
  - Zone of aeration: pores filled with air and water
  - Water table: seperates the zones
- Movement of groundwater
  - Porosity: amount of open space in rock or sediment
  - Permeability: How well water flows through rock or sediment **(64)**



An aquitard is impermeable
An aquifer is permeable

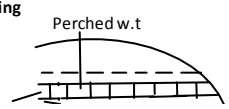
  - Flow under gravity from high areas to low areas along curved paths **(65)**

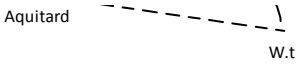
Groundwater Flow Paths

Flowpath of water molecules

  - Springs: natural outpouring of water onto the ground surface; **(66)**

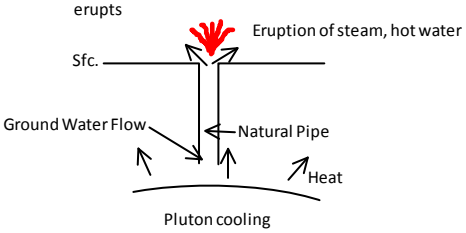
Spring



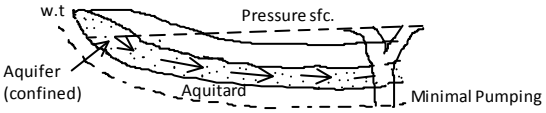


May involve a water table that is "perched" on an aquitard

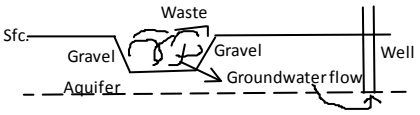
- Hot springs: where groundwater is heated by the geothermal gradient or by cooling magma
- Geysers: cyclic events where groundwater is heated in a rock pipe, boils, then vaporizes and erupts



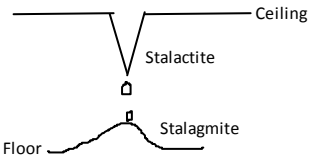
- Wells
  - Wells: where humans drill into the water table, creating a cone of depression in it
  - Artesian wells penetrate an aquifer confined by aquitards; requires minimal plumbing **(68)**



- Problems w/ groundwater
  - Subsidence: can result from excessive pumping of water that causes aquifer sediment to compact and ground surface to settle
  - Groundwater contamination: from septic tanks, chemical spills, fertilizers, leaking pipes, tanks, landfills **(69)**



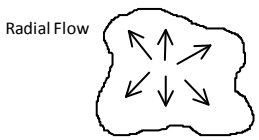
    - Pollutants can make their way into aquifers used for drinking water; locate landfills only in aquitards
- Work of groundwater
  - Caverns: form below the water table where groundwater dissolves soluble rocks
    - After the water table is lowered stalactites grow down cave ceilings and stalagmites grow up from cave floors **(70)**



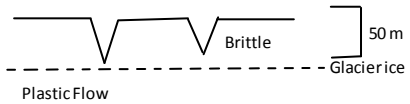
- Karst topography: landscape formed by groundwater dissolving soluble rocks
  - Cave-ins of cavern ceilings result in sinkholes into which streams can dissapear

CHAPTER 17- GLACIERS AND GLACIATION 11/19/2013

- Glaciers
  - Ice sheet: continental scale, radial flow from a central area **(71)**



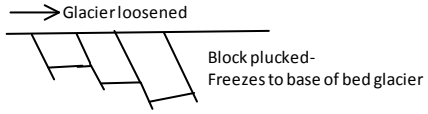
  - Valley: in mountains, flow down valleys by gravity
- Movement of a glacier
  - Upper brittle zone of fracture rides passively on lower deforming plastic zone that may also slide over the glacier's bed **(72)**



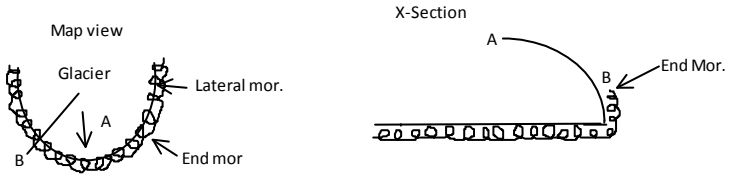
- Budget of a glacier:
  Accumulation>ablation,
  Terminus advances

  Accumulation<ablation,
  Terminus retreats

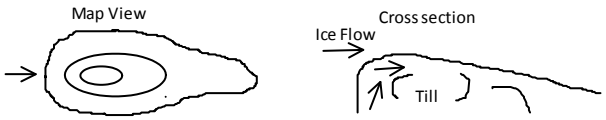
- Movement is always forward
- Glacial erosion
  - Plucking: freeze-on of loose rock **(73)**



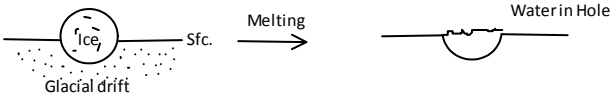
  - Abrasion: rock debris in glacier's sole grind, scrape, scour rock
    - Results in striations, grooves on rock
- Landforms created by glacial erosion
  - Glaciated valleys: U-shaped
  - Cirques: rock bowls at heads of valley glaciers
  - Fjords: U-valleys along coasts
  - Arêtes, horns: Sharp mountain ridges and peaks
- Glacial Deposits
  - Till: stony mid with striated and polished stones
    - Main materials in moraines and drumlins that form along the edge of or under the glacier
      (74) Moraines (till)



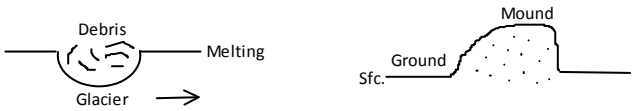
- **(75) Drumlin**



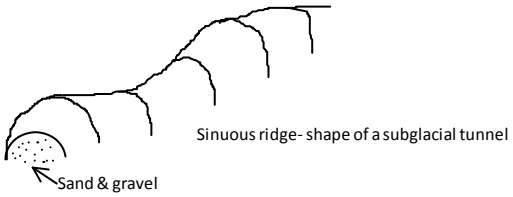
- Stratified drift: sand and gravel from melt-water; forms…
  - Kettle- rounded pit from a melted ice block **(76)**



  - Kame- mound lowered from glacier's surface on melting **(77)**



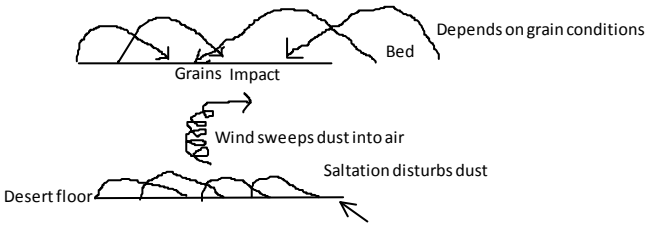
  - Esker- winding ridge from subglacial tunnel **(78)**



- Causes:
  - Plate tectonics
  - Minimum contrast in seasons in mid-high latitudes

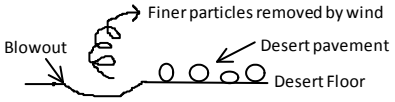
CHAPTER 18- DESERTS AND WINDS 11/21/2013

- Occur in areas with low precipitation, and little vegetation
- Geologic processes
  - Weathering: mainly mechanical with some oxidation
  - Water: mainly ephemeral streams and "flash" floods
- Transportation of sediment by wind
  - Bedload: mainly by saltation (bouncing, skipping); depends on grain collision **(79)**
    Desert Saltation



  - Suspended load: dust swept into the air and carried far away
- Wind erosion

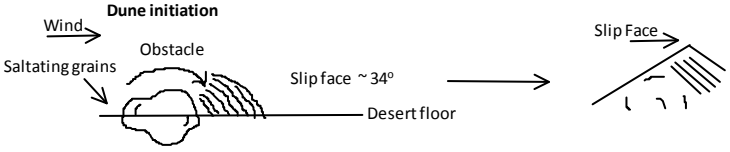
- Deflation: wind removes fines, leaving blowouts, and coarse particles as desert pavements **(80)**



- Abrasion: saltation sadblasts rock and stones, creating ventifacts and yardangs

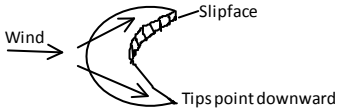
- Wind deposits
  - Sand dunes: form downwind of obstacles where a steeper slip face develops opposite the shallower upwind side **(81)**

Dune initiation

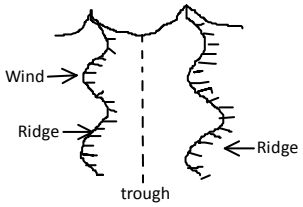


    - Dunes migrate downwind

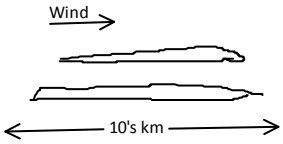
- Dune types:
  - Barchan: crescent-shaped dunes whose tips point downwind **(82)**



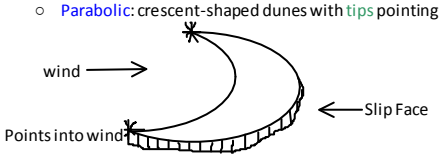
  - Transverse: ridges and troughs at right angles to the wind



  - Longitudinal: long ridges parallel to the wind



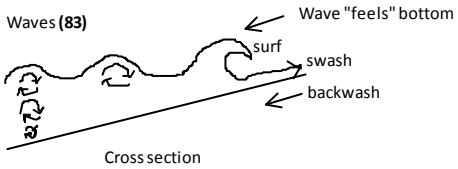
  - Parabolic: crescent-shaped dunes with tips pointing upwind, anchored by plants **(blowout)**



- Loess: deflated dust from deserts or from freshly exposed glacial sediments
  - Carried far then deposited, today makes good farmland

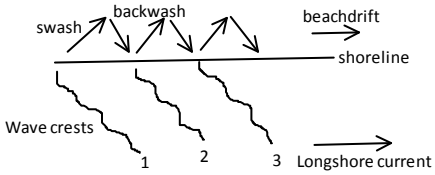
CHAPTER 19- SHORELINES 11/26/2013

- Waves **(83)**



  - Wind-generated energy forms that move through water
  - "feel bottom" as approach the shore then break into surf
    - Swash and backwash
  - Erosion: mainly by abrasion of headlands
- Sand movement on the Beach
  - Wave refraction: waves bend toward irregular shoreline to erode headlands, and deposit in bays
  - Sawtooth pattern of swash and backwash results in...
    - Beach drift, longshore current that transport sediment along the shore **(85)**

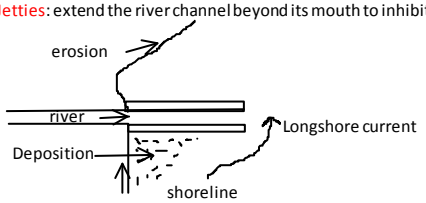
Beach drift



- Erosional Features

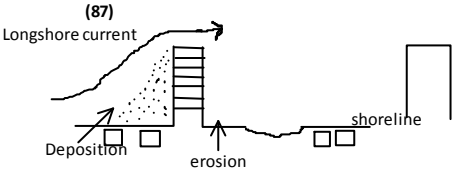
- Wave-cut cliffs: by surf erosion, leaves a wave-cut platform
- Arches: where surf cuts through caves in a headland; may collapse to form stacks

- Depositional features
  - Spits: beach drift forms sand ridges into mouths of bays; may become a bay-mouth bar
  - Tombolo: sand ridge connecting mainland to an island
    - Eventually shorelines straighten
- Stabilizing the shoreline
  - Jetties: extend the river channel beyond its mouth to inhibit beach drift **(86)**

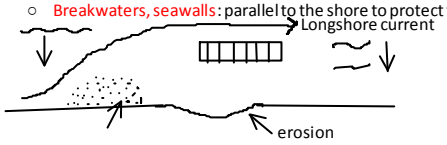


  - Groins: at right angles to the shore; sand deposited on up-drift side, erosion on down-drift side

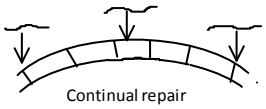
(87)



  - Breakwaters, seawalls: parallel to the shore to protect from storms **(88) breakwater**



(89) seawall



- Beach nourishment: requires a lot of sand, very expensive
- Relocation: best move away from worst storm erosion areas

CHAPTER 20- MINERAL AND ENERGY RESOURCES 11/28/2013

- Metallic mineral deposits
  - Called ore if mined for profit
    - Magmatic: early crystal settling of chromite, magnetite, platinum;
    - Late crystalization of lightest minerals in pegmatites
    - Hydrothermal: hot fluids with metals precipitate ore in vein deposits (gold, silver); Disseminated deposits spread through host rock;
    - Volcanogenic massive sulphide deposits in ancient sea floor at oceanic ridge
    - Sedimentary: banded iron formation in Precambrian sea; Placer deposits of gold, diamonds by running water
  - Metamorphism: skarns by plutons cooking limestone
  - Weathering: bauxite forms in tropics, provides aluminum ore
- Nonmetallic Resources
  - Aggregate and stone: crushed stone, sand, gravel mined for concrete and asphalt; Cut stone for decoration
  - Industrial minerals: diamonds for abrasives, gemstones; form deep in mountain belts but mined from kimberlite pipes;
    - Clay for bricks, drainage pipes, potter; weathered silicates; Calcite for cement, asphalt
    - Evaporite salts: gypsum for plaster, salt for food etc., potash for fertilizer
    - Phosphate and sulphur for agriculture
- Nonrenewable Energy Resources
  - Petroleum: for fuel, plastics; forms from decayed marine plankton under deeply buried sediments
    - Oil, gas migrate up into reservoir rocks, get trapped in petroleum traps where they hit cap rock
  - Coal: for fuel, from buried, decayed land plants in ancient swamps
  - Heavy oil sands: hoghly viscous, hard to extract oil from sand
  - Nuclear: from uraninite ore, energy from spitting uranium atom
- Renewable fuel resources
  - Hydroelectric: dams on streams provide clean energy but reservoirs fill with sediment
  - Geothermal: steam in volcanic areas is piped to turbines to generate electricity

YOU'RE WELCOME BITCHES
-LOVE, CELINE