Dynamic Earth - GLY 1
Final Exam Review and Brief Notes – Fall 2011

rocks

you should know the difference between igneous, sedimentary, and metamorphic rocks, how they form, and examples of each

earth's interior

- how earthquake seismology is useful for determining the internal structure of the earth
- wavefronts and ray paths
- major subdivisions of the earth from core to surface & the materials that make them up
- Moho: what it is (crust-mantle boundary) and how it was discovered
- characteristics (thickness, composition, density, age) of continental crust, oceanic crust, and mantle rock
- the core: P and S wave shadow zones, inner and outer core
- evidence/arguments for core composition: must be high density material common in the solar system, and account for
  seismic velocity and fluctuating magnetic field (core convection)
- low velocity zone - asthenosphere, lithosphere, tectonic plate the seismic evidence and the asthenosphere, what may cause it, it's significance for plate tectonics

be able to draw simple sketches to show how the crust-mantle boundary and mantle-core boundary were discovered

earth's interior and mantle convection

- mechanisms for cooling the earth:
  conduction? No, b/c rock is a good insulator, poor conductor
  convection? Yes, b/c rock in the mantle is ductile and can very slowly "flow"

continental drift and plate tectonics

- Wegener's 4 lines of evidence for continental drift
  jigsaw puzzle fit of the continents
  truncated geologic features: matching geology on opposite sides of the Atlantic
  far-flung fossil: same species in presently geographically isolated locations
  paleoclimate indicators: late Paleozoic age glacial deposits on southern continents
    and tropical coals on the northern continents
- Why Wegener's theory wasn't accepted
    no plausible mechanism that could move continents
- paleomagnetic evidence for continental motions
  magnetic inclination indicates ancient latitude; magnetic direction indicates direction to the pole
  ancient apparent poles changed from ancient rocks to recent rocks
  each continent has its own apparent polar wander path
  therefore these distinct pole paths indicate the movement of the continents
- marine magnetic anomalies and seafloor spreading
  magnetization of the ocean crust in alternately normal and reverse polarity strips
  parallel to midocean ridges were evidence for seafloor spreading

- evidence for seafloor spreading and plate motion
    - fancy GPS measurements (Very Long Baseline Interferometry)
    - normal fault earthquakes at midocean ridges (stretching)
    - deep sea submersible observations of normal faults and new lava flows at midocean ridges
    - age pattern of ocean crust from radiometric dating of drill cores

plate boundaries

- divergent plate boundaries
  - midocean ridges
    - plates spread apart and new crust forms
    - source of magma: decompression (partial) melting of upwelling mantle...
    - ridge stands high b/c lithosphere & asthenosphere hot & expanded
    - lithosphere cools & contracts as it moves away
  - continental rifts (e.g., East African Rift)
    - may continue to stretch and eventually form new midocean ridge, or stop stretching to become a failed rift
- convergent plate boundaries
  - ocean-ocean subduction zone (e.g., Aleutians, Mariana, Philippine, Japan)
  - continent-ocean subduction zone (e.g., Andes)
    - deep ocean trench and volcanic arc (continental or island arc) parallel to trench
    - magma produced by flux melting of mantle above subducting crust after crust releases water by metamorphism
    - Benioff zone: plane of EQs descending from trench, down as deep as ~670 km; shows location of subducting slab
  - continent-continent collision (e.g., Himalayas, Appalachians)
    - orogenic belt
- transform plate boundaries
  - oceanic transforms: ridge offsets
    - transform faults and fracture zones
  - continental transforms: (e.g., San Andreas, North Anatolian Fault in Turkey)
- earthquakes occur at all plate boundaries!
  - divergent (normal faults), convergent (thrust faults), transform (strike-slip faults)
- igneous activity occurs at convergent (subduction zones), divergent boundaries and also in the middle of plates at hotspots

hotspot tracks (like the Hawaiian/Emperor chain of islands and seamounts)
- volcanically active at one end; volcanoes get progressively older down the chain
- fed by mantle plumes: rising conduit of hot, solid mantle rock, perhaps from the core-mantle boundary
- the rising mantle rocks begin to partially melt near the base of the lithosphere due to reduced pressure (decompression melting)

be able to draw profiles and maps of midocean ridges, subduction zones, transform and fracture zones, and hotspots/mantle plumes

groundwater

- the hydrologic cycle: precipitation = runoff + infiltration + evapo-transpiration
- porosity, permeability
- zone of aeration, zone of saturation, water table, aquicludes, cone of depression, drawdown
- groundwater flows from where water table is high to where it is low
- unconfined aquifers, confined aquifers
- pressure (potentiometric) surface (confined aquifers)
- typical permeable materials that make good aquifers: sand, gravel, sandstone, limestone
- impermeable aquiclude materials: clay, shale, joint-free igneous and metamorphic rocks
- water wells, how they work, town water supplies and water towers
- landfills (garbage dumps) and our groundwater supply; sanitary landfills
- lawn and agricultural chemicals
- land subsidence from over-pumping
- saltwater intrusion
- Long Island's groundwater system

be able to draw profile of the groundwater system, including wells, cones of depression, etc.

karst

- acidic water dissolves limestone
  makes caves, caves collapse, produce
- sinkholes

streams

- the work of streams: erosion, transport, deposition
- stream discharge (Q = VA)
- stream velocity profile (slowest along stream bed and banks - friction)
- cross-sectional shape of stream channel and ease of flow *(hydraulic radius)*
- stream transport - bed load, suspended load, dissolved load
- deposition vs transport vs erosion depending on stream velocity (Hjulstrom's curve)
- relationship of groundwater and surface water (surface streams, lakes, swamps)
  gaining and losing streams; perennial vs. intermittent and ephemeral streams
- stream networks, stream orders
  discharge increases down a stream network into higher and higher order streams
- meandering streams: velocities across a bend -> point bars, cut banks, oxbow bends and oxbow lakes
- floodplains, valley walls, natural levees, stream terraces
- youthful, mature, and rejuvenated stream characteristics (profiles and map views)
- stream deposits (point bar sands, natural levee sands, floodplain muds)
- stream velocity at flood stage vs. slow water
- stream hydrographs: why does stream discharge slowly increase and peak hours or days after major rains?

be able to draw profile and map views of streams and stream valleys *(esp. youthful & mature)*

coastal processes
- shorelines are modified by waves, tides, storms, and changing sea level
- size of waves determined by wind speed, duration, and fetch
- crest, trough, wavelength (L), period (T)
- orbital motion of water as wave passes, decreases to zero at depth of L/2
- what happens to a wave as it approaches shore (when water depth < L/2)
- breakers, swash, backwash
- beach profile: shoreface, berm, dune
- winter/summer profiles (cause of differences)
- coastal sedimentation: coarse along the shoreline, progressively finer going offshore: why?
- littoral (longshore) drift caused by waves approaching shore at an angle
- wave refraction
- tides: moon & sun, phases of the moon, spring and neap tides
- coastal storms and beach erosion:
  storm surge from wind setup and inverted barometer effect
  beach erosion due to large waves, wind setup, and return flow
  worst erosion & flooding in storms at high tide of the spring tides
- sea level rise from thermal expansion of the oceans and melting of glaciers as Earth warms
- small sea level rise = large landward shoreline retreat on gently sloping coastal plain of the eastern U.S.
- combined effects of slowly rising sea level and coastal storms (especially high tide of the spring tides)
- effects of groins, seawalls, beach nourishment

be able to draw simple profile and map views of the coast showing features and processes

glaciers
- alpine glaciers and continental ice sheets
- formation of glacial ice: snow-firn-ice
- zone of accumulation, zone of ablation
- moves via internal ductile flow, basal sliding (where warm enough)
- abrasion and plucking, glacial striations
- U-shaped glacial valleys: steep-sided with wide valley floors (unlike youthful or mature streams)
- glacial till: unsorted boulders, cobbles, pebbles, sand, and lots of “rock flour” (silt) from ground up rock
- terminal moraines, ground moraine: unsorted till deposited at/near end of glacier
- outwash plains: sorted sediments transported away from moraines by meltwater streams
- glacial features on Long Island: Harbor Hill & Ronkonkoma moraines, outwash plain to the south
- glacial features in Central Park: striated bedrock (Manhattan Schist), roches moutonées (asymmetrically streamlined bedrock knobs), glacial erratics