

## I. Formation of Solar System

## A. Nebular hypothesis

1. rotating cloud of gases and dust
2. collapses, heats to form Sun
3. cooling allows rocky elements to condense in inner
  - a. particles accrete to stony planets
  - b. small, warm, don't attract lighter gases
4. water, methane, ammonia, carbon dioxide are ices in outer disc
  - a. accumulate with rocky elements into large bodies
  - b. greater gravity allows retention of hydrogen and helium

## B. 8 major planets

1. four inner stony, small
2. four outer gas giants
3. significant other bodies
  - a. asteroids
  - b. Kuiper-belt objects, which Pluto probably belongs
  - c. Miscellaneous dust, meteors, comets

## II. Earth spheres

## A. Three major spheres

1. atmosphere, thin envelope
2. hydrosphere covers more than 71% of surface
3. geosphere—from hydrosphere to center
4. Biosphere penetrates all three,
  - a. only thin zone
  - b. has created significant changes, especially to atmosphere
5. interaction has sculpted surface to what it is today

## B. Geosphere can be divided by composition or physical properties

1. three compositional divisions
  - a. crust
    - 1) least dense, thinnest, coolest
    - 2) two types: continental and oceanic
      - a) oceanic ~7 km thick, basalt,  $3 \text{ g/cm}^3$
      - b) continental ~40 km thick, granitic,  $2.7 \text{ g/cm}^3$
  - b. mantle
    - 1) 2900 km depth
    - 2) Depleted in silica compared to crustal rocks
    - 3) Upper part has density  $\sim 3.4 \text{ g/cm}^3$
  - c. Core
    - 1) Iron-nickel alloy
    - 2) 3480 km radius
    - 3) Density  $\sim 13 \text{ g/cm}^3$
2. five divisions based on physical properties—(only one of these boundaries corresponds to composition boundary)

- a. lithosphere
  - 1) brittle, solid, broken into plates
  - 2) averages 100 km thick—from 5 to 250 km
  - 3) includes all of crust, and upper part of mantle
- b. asthenosphere
  - 1) almost at melting stage—
    - a) pressure keeps it from melting completely
    - b) release in pressure allows partial melting into magma
  - 2) weak compared to overlying lithosphere
  - 3) lithosphere moves around on this slushy upper mantle zone
  - 4) to depth of 660 km
- c. lower mantle
  - 1) increase in pressure increases strength
  - 2) solid, but capable of gradual flow
  - 3) 2240 km thick
  - 4) ends where liquid of outer core begins
- d. outer core
  - 1) molten metal flows to create Earth's magnetic field
  - 2) 2260 km thick
- e. inner core
  - 1) pressure makes it solid
  - 2) 1220 km radius

### III. Nature of Earth's surface

- A. Lithosphere broken into plates that move over weak asthenosphere
  - 1. movement due to convection of heat from inner Earth to surface
  - 2. plates composed of crust and some mantle
  - 3. most plates have continental and oceanic crust on them
  - 4. interaction of edges where relative movement is apparent
    - a. divergent
      - 1) pressure release allows underlying asthenosphere to melt and fill in
      - 2) creates basaltic rock
    - b. convergent
      - 1) oceanic crust can be forced down into mantle--subducted
      - 2) plates carrying continental crust too buoyant to subduct
    - c. lateral ('transform') boundaries where plates slide past one another
- B. Features of ocean basins
  - 1. much is expansive flat areas—abyssal plains
  - 2. deep ocean trenches where sea floor is bent by subduction
    - a. narrow zones bordered by young mountain ranges
    - b. subduction creates uplift of these by generation of magma
  - 3. oceanic ridge system formed at divergent boundaries
    - a. broad, gentle uplift may or may not be in center of basin
    - b. interconnected to form largest volume of mountain range on Earth—70,000 km long

### C. Features of continents

1. shoreline a coincidence of volume of ocean basin and amount of liquid water
    - a. actual boundary between oceanic basin and continents due to type of crust upon lithosphere plate
    - b. sea water laps up onto continental surfaces in zones of various widths
    - c. 40% of Earth's surface is continental, although about  $\frac{1}{4}$  of this is covered with sea water at present
  2. Mountain belts rise high above average elevation of continents
    - a. Two major zones
      - 1) Circum-Pacific belt
      - 2) Alpine-Himalayan chain
    - b. Both result of lithospheric plate convergence
  3. continental shield composed of remnants of ancient mountain belts
    - a. folded crystalline rock
    - b. stable, not near lithosphere plate boundaries
  4. stable platform
    - a. has thin veneer of sedimentary rock deposited on them
    - b. may be only fundamental difference to shield
- IV. Earth is a system, with the spheres continually interacting
- A. Parts are linked, and action in one changes another
  - B. Cycles repeat motion over short or enormous lengths of time
  - C. Energy for system
    1. External—provided by Sun
    2. Internal—original heat of gravitational contraction, and by radioactive decay